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An Investigation of Foreign By-Product Coke Plant and Blast Furnace Wastewater Control Technology and Regulation

Hydrotechnic Corp., New York

Prepared for

Industrial Environmental Research Lab.
Research Triangle Park, NC

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AN INVESTIGATION OF FOREIGN BY-PRODUCT COKE PLANT AND BLAST FURNACE WASTEWATER CONTROL TECHNOLOGY AND REGULATION

Prepared for

Office of Environmental Engineering and Technology

Prepared by

Industrial Environmental Research
Laboratory
Research Triangle Park NC 27711

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16. ABSTRACT

The report gives results of a study to determine if more effective wastewater control technologies for by-product coke plant and blast furnace gas-cleaning wastewaters are used in foreign plants than in the U.S. Some unusual techniques for treating blast furnace gas-cleaning wastewaters were found. Aeration of the wastewater prior to clarification improved settling and allowed a greater rate of recirculation. Filtering the wastewater through slag or flue dust removed cyanide. Treating by-product coke plant and blast furnace gas-cleaning wastewater is, in general, not more advanced in foreign plants than in the U.S. However, blast furnace gas-cleaning water in foreign plants is generally recycled to a greater degree. Also, highly qualified and experienced wastewater treatment plant operators and high level plant management involvement was frequently observed at foreign plants. A noticeable spirit of cooperation between regulators and industry was observed in many countries. Discussions were held with plant and corporate personnel at 26 plants in 14 countries and with regulatory agencies in 10 of the 14 countries to determine the regulations imposed on the plants, the incentives provided to reduce pollution loads to receiving waters, and the treatment technologies used. Research project recommendations are presented for promising wastewater treatment techniques.

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Water Treatment		Wastewater Control	
Coking		Gas Cleaning	13H
Blast Furnaces			11F
Aeration			07D

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ABSTRACT

This study was to determine if more effective wastewater control technologies for by-product coke plant and blast furnace gas cleaning wastewaters are being used in foreign plants than in domestic ones. Some unusual techniques for the treatment of blast furnace gas cleaning wastewaters were found. Aeration of the wastewater prior to clarification improved settling and allowed a greater rate of recirculation. Filtering the wastewater through slag or flue dust removed cyanide.

Treatment of by-product coke plant and blast furnace gas cleaning wastewater is, in general, not more advanced in foreign plants than in the United States. However, blast furnace gas cleaning water in foreign plants is generally recycled to a greater degree. Also, highly qualified and experienced wastewater treatment plant operators and high level plant management involvement was frequently observed at foreign plants. A noticeable spirit of cooperation between regulators and industry was observed in many countries.

Discussions were held with plant and corporate personnel at 26 plants in 14 countries and with regulatory agencies in 10 of the 14 countries to determine the regulations imposed upon the plants, the incentives provided to reduce pollution loads to receiving waters and to investigate treatment technology.

Recommendations for research projects are made as there appear to be promising areas for improvement of wastewater treatment techniques.

This report is submitted by Hydrotechnic Corporation in fulfillment of Contract No. 68-02-3123 sponsored by the United States Environmental Protection Agency.

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	Australia Iron and Steel, Hoskins-Kembla Works
	John Lysaght (Aust.) Ltd.
	Matthew-Hall Pty, Ltd., Sydney, Australia
BELGIUM	SIDMAR
BRAZIL	FMC-Filsan, Sao Paulo, Brazil
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	British Iron and Steel Corporation - Scunthorpe Works and Orgreave Works
FRANCE	Pont-a-Mousson
ITALY	Italsider, S.p.A., Taranto Works
JAPAN	Environment Agency
	Ministry of International Trade and Industry

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	Kawasaki Steel Corp., Chiba Works
	Kobe Steel Ltd., Kakogawa Works
	Nippon Kokan KK
	Sumitomo Metal Industries. Kashima Works
MEXICO	Subsecretaria de Mejoramiento del Ambiente
	Secretaria de Salubridad y Asistencia
	Secretaria de Recursos Hidraulicos
	Altos Hornos de Mexico
NETHERLANDS	Ministry of Public Health and Environmental Protection
	Ministry of Traffic and Water Management
	Hoogovens, IJmuiden
SOUTH AFRICA	Department of Water Affairs, Pollution Control Commission
	ISCOR, Headquarters Pretoria Works Newcastle Works Vanderbijlpark Works
SWEDEN	National Swedish Environment Protection Board
	Svenskt Stal. Norrbottens Jarnverk
	Surhammars Bruks AB, Spannarhyttan
	Aquator AB, Stockholm, Sweden
TAIWAN	Taiwan Water Pollution Control Agency - South Division Control Center
	China Steel Corporation - Kaohsiung

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WEST GERMANY	Emscher Genossenschaft
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SECTION 1.0

SUMMARY AND CONCLUSIONS

Several unusual methods of reducing cyanides in blast furnace gas washer water were found during a study of wastewater treatment practices in foreign steel mills. These methods may be applicable to wastewaters from domestic steel mills after study to determine the exact removal mechanisms.

GENERAL

Twenty-five foreign steel and steel related plants in fourteen countries were visited to determine if the methods they use to treat by-product coke plant and blast furnace gas washer wastewaters are more advanced than methods currently used in the United States. Most plants visited had both by-product coke plants and blast furnaces on site and thus the plants can be considered as part of integrated mills. The information obtained should be of interest and value to the United States steel industry and to Federal and State agencies who regulate the discharge of wastewater.

Governmental regulatory agencies in ten countries were also visited to obtain their discharge regulations, both present and projected. This information was used to see if certain treatment works were built to meet regulations or because it was economically feasible to do so.

The wastewater treatment systems observed at the foreign by-product coke plants and blast furnaces are basically similar to those presently operated in the United States. As noted below, however, there are several unusual treatment methods not used domestically that may be of some value in this country.

SUMMARY

Blast Furnace Gas Washer Water

1. Washer water was sparged with steam at one plant in Sweden. While this was done to prevent freezing, there was a significant cyanide removal. Whether this process is economically feasible in the United States should be studied.

2. Washer water filtration through flue dust removed cyanide. The water must be in the alkaline state but further details of the removal mechanism are not known.

3. Cyanide is also removed from washer water when the water is passed through slag. Again the removal mechanism is not known.

4. Aeration of washer water prior to clarification improves settling. This, in turn, enhances the possibility of increased recirculation rates.

Coke Plant Wastewater

1. Tar can be removed from coke plant wastewater prior to biological treatment, by filtering the water through a "rough" coke filter. It is difficult, however, to clean the filter.

CONCLUSIONS

1. Foreign effluent quality regulations are usually negotiated between government and industry on a case-by-case basis. The economic impact of any regulations is a major concern.

2. Other than phenol and cyanide, priority pollutant removal is not normally considered in the design and operation of wastewater treatment facilities at foreign plants.

3. Blast furnace gas washer water at foreign blast furnaces is generally recirculated to a greater degree than in the United States. Systems with zero water discharge, however, were not found. Some plants with recycle rates of less than 50 percent were observed.

4. Consumptive disposal of by-product coke plant and blast furnace wastewater by quenching of incandescent coke and hot slag was observed at many of the plants.

5. The combined treatment of domestic sewage and by-product coke plant wastewater in a biological treatment plant is practiced.

6. The disposal of certain wastewaters by irrigation was observed.

7. Temperature of biological treatment plants can be controlled effectively in cold climates if the treatment basins are enclosed.

8. Slag quenching pits that were covered to avoid or reduce possible air pollution were observed at one plant.

9. Effective and efficient operation of wastewater treatment plants usually goes hand-in-hand with:

a) An awareness of the wastewater systems by senior plant and corporate engineers.

b) Good housekeeping practices, and

c) Qualified and experienced operators.

10. In some treatment plants plant operators participate in the production bonus program. This encourages operators to remain in wastewater treatment departments rather than transferring to the production staff.

11. Based on observations at foreign plants and domestic plants, further research into wastewater treatment technology should be undertaken. Areas needing further research are discussed in Section 7.4 of this report.

Specifically, the research areas addressed are:

a) Cyanide removal from blast furnace gas washer wastewater.

b) Recirculation of gas washer wastewater.

c) Treatment of by-product coke plant wastewater.

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SECTION 2.0 - INTRODUCTION

2.1 PURPOSE OF THE PROJECT

Hydrotechnic Corporation received an assignment September 21, 1978 from the United States Environmental Protection Agency (EPA), Office of Research and Development, to study wastewater treatment practices at foreign steel mills, by-product coke plants and blast furnaces. The objective was to determine if any foreign techniques were more advanced than those presently practiced in the United States. If there were advanced foreign technologies, engineering plans and cost estimates of typical systems were to be developed. These designs and estimates would then be used to see if the advanced technologies could be implemented in the United States. Technologies that could form the basis of "innovative technology incorporating best engineering judgement" were included in the study and were referred to as "foreign based" technology.

2.2 SCOPE OF WORK

The scope of work for this project is composed of six tasks, viz:

> "Task 1. Evaluate foreign technology for the control of wastewater discharges from the blast furnace and the by-product coke plant. The by-product coke plant discharges of interest include coke oven gas scrubbing and subsequent by-product plant discharges along with other discharges resulting from related operations with which it may be combined for wastewater treatment. The blast furnace discharges of interest include top gas scrubbing and contact cooling along with other discharges resulting from other related operations with which it may be combined for wastewater treatment. The evaluation shall be limited to pollution control technology that is either not used in the domestic industry or used in an improved fashion and which in the engineering judgement of the evaluator, has the capability of being used in and being superior in control efficiency to the technology in the domestic industry. However, all control technology that is found to be used should be documented. For purposes of the evaluation,collect all available data including but not necessarily

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operating parameters; energy requirements; costs; drawings and sketches; other environmental considerations (air, solid waste, noise, etc.); etc. The sources of the data shall include as a minimum the literature and plant site visits. Where sufficient data is not available, supplement the available information with engineering analysis. All visits shall be coordinated with the EPA Project Officer.

"Task 2. Compare the foreign technology with the capabilities of technology used in the domestic iron and steel industry for similar sources. For comparison, the domestic technology shall be evaluated in the same manner as was the foreign technology. A prime source of information and data relative to domestic steelmaking wastewater treatment are the drafts of the Effluent Guidelines Limitation Documents that will be developed during the term of this contract. To properly make use of this above data, it will be necessary to review, analyze, and where appropriate, apply the information within these documents. In the event that insufficient foreign technology is found that offers superior wastewater control, then the foreign technology observed would form the basis of innovative technology that incorporates the best features of the foreign technology and best engineering judgement. The resulting technology shall be referred to as "foreign based" technology.

"Task 3. Determine for which of the sources the foreign or foreign based control technology exhibits superior wastewater control capability. Consideration shall be given to the ability to reduce total pollutant discharge per unit of production. That is, technology that results in either a wastewater flow reduction or a final effluent pollutant concentration reduction, or both, shall be considered.

"Task 4. Rank, using best engineering judgement, the foreign or foreign based pollutant control technology in order of decreasing ability to lower the quantity of pollutants that are discharged. Be descriptive in how the best engineering judgement was applied.

"Task 5. For the five highest ranked sources and technology, and with the concurrence of the EPA Project Officer, prepare a detailed engineering description of each installed upon a typical process in the domestic iron and steel industry. Included shall be preliminary layout drawings, costs - both capital and operating, estimates of effluent discharge reduction, energy requirements, plus other information that might be of interest to a potential user.

"Task 6. For each of the five technologies, discuss potential improvements that may be undertaken to improve effluent discharge, reduction, energy requirements, operability, maintainability, etc."

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SECTION 3.0

DESCRIPTION OF PRODUCTION PROCESSES

3.1 COKE PLANTS - GENERAL

Coal is distilled in the coke plant to furnish elemental carbon (coke) necessary for the production of iron in blast furnaces. There are two current methods for manufacturing coke: the beehive or non-recovery process and the by-product or chemical recovery process. The by-product process accounts for over 99 percent of all metallurgical coke produced in the U.S. so the beehive process is not given further mention in this report.

3.1.1 Manufacturing Process

By-product coke is produced by heating bituminous coal in closed ovens, in the absence of air, to remove volatile components. The heat necessary for this distillation process is supplied from the external combustion of coke oven or blast furnace gas in flues located within the oven walls. The residue in the ovens after distillation is coke and the volatile components are in a gas. The gas is then processed in a by-product plant. Coke ovens are placed side by side in a "battery".

During the coking period, the distilled gases and volatiles are collected in a collection main running the length of the coke battery. At the end of the coking period, the oven doors are removed and a pushing machine forces the hot coke into a quench car. The car then moves to a quenching tower where the incandescent coke is cooled by water sprays. The quenched coke is then delivered to a handling and holding area for subsequent use.

The gases and volatiles collected from the coke ovens are processed in a by-products plant where coke oven gas, tars, inorganic chemicals and organic chemicals may be recovered.

A schematic diagram of a by-product operation is shown on Figure 3-1. The raw gases are first cooled by sprays of flushing liquor in the collection main and in a primary cooler. Water and tar are condensed from the gas and carried away by the flushing liquor. Tar is then decanted for recovery.

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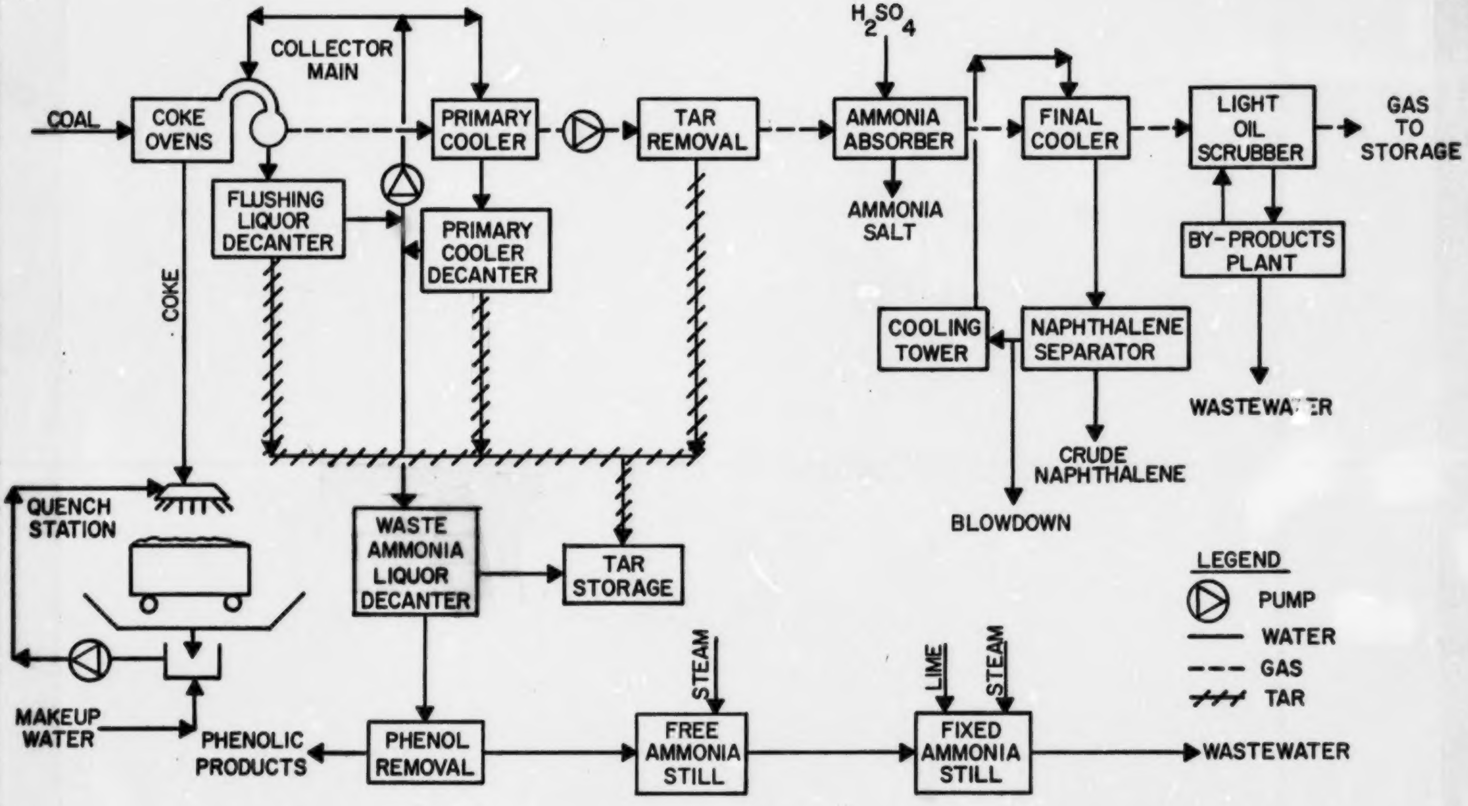
COAL
COKE OVENS
COLLECTOR MAIN
PRIMARY COOLER
TAR REMOVAL
H_2SO_4
AMMONIA ABSORBER
AMMONIA SALT
FINAL COOLER
LIGHT OIL SCRUBBER
GAS TO STORAGE
BY-PRODUCTS PLANT
WASTEWATER
FLUSHING LIQUOR DECANTER
PRIMARY COOLER DECANTER
COOLING TOWER
NAPHTHALENE SEPARATOR
CRUDE NAPHTHALENE
BLOWDOWN
COKE
QUENCH STATION
WASTE AMMONIA LIQUOR DECANTER
TAR STORAGE
MAKEUP WATER
PHENOLIC PRODUCTS
PHENOL REMOVAL
STEAM
FREE AMMONIA STILL
LIME
STEAM
FIXED AMMONIA STILL
WASTEWATER
LEGEND
PUMP
WATER
GAS
TAR

FIGURE 3-1 TYPICAL BY PRODUCT COKE PLANT PROCESS FLOW DIAGRAM

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Most of the flushing liquor is recycled for spray cooling of the gas. A blowdown-waste ammonia liquor (WAL) which contains ammonia, phenol, cyanide, sulfide and suspended solids is decanted for further tar removal and then directed to phenol removal facilities. The coke oven gas may then pass through a tar precipitator, an ammonia absorber (ammonia recovery), a final cooler (naphthalene removal), a light oil scrubber and possibly a desulfurizer before use of fuel. Wash oil from the light oil scrubber is stripped of absorbed light aromatic oils in by-products plants which vary in specific processes and extent of chemical recovery.

3.1.2 Water Use

At coke and by-products plants water is not completely recovered from all the processes so there is a loss of water. At the same time some water bound up in the coal is released so there is an offsetting gain. The net water gain is a function of coke production, the type of coal used, the extent of by-product recovery and production, the design of the specific coke making and by-product units and the degree of water recycling employed. From 70 to 95 percent of the water applied at a coke plant is for indirect cooling and the water is usually cooled and recirculated. Coal preparation, air pollution control methods and by-product operations vary from plant to plant and, therefore, so do the quantity and quality of the wastewater streams. The primary sources of contaminated liquid wastes at a typical by-product plant are waste ammonia liquor (WAL), final cooler condensates, and wastewater produced as a result of light oil recovery.

Water is lost by evaporation and drift at cooling towers and coke quenching operations. The quantity of water evaporated at coke quenching operations at the foreign coke plants reportedly varied from 0.3 to 2.5 m^3/Mg* (72 to 600 gallons per ton) of coke quenched. This rather large variation does not seem reasonable. In the United States, the reported coke quenching water consumption ranges from 0.54 to 1.08 m^3/Mg (130 to 260 gallons per ton).(1)

The volume of WAL production was compared between twenty-one foreign and seven domestic plants. The results are tabulated on the following page.

---

* Mg will be used throughout this report. It is equivalent to kkg which appears exclusively in the Proposed Effluent Guidelines. It is also equivalent to metric ton (tonne).

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	Foreign	Domestic
Number of Plants	21	7
Daily Coke Produced	102,400 Mg (112,600T)	17,300 Mg (19,000T)
Number of Ovens	4760	N.A.
WAL	0.14-0.74 m^3/Mg (34-178 gpt)	0.11-0.24 m^3/Mg (26-58 gpt)
WAL Avg.	0.28 m^3/Mg (67 gpt)	0.15 m^3/Mg (36 gpt)

Other discharges which may enter the by-product coke plant wastewater system are: coke wharf drainage, equipment drips, runoff from precipitation, final cooler wastes where direct cooling is used and, at very few installations, quench basin overflows.

Most by-product plants practice some degree of contaminant removal for product recovery rather than for wastewater treatment per se. The most common processes are: 1. Gravity separation for the recovery of oils and tars, 2. An ammonia still for the recovery of ammonia from WAL for the manufacture of ammonium sulfate or for burning with the coke oven gases, 3. Stills for the removal of fixed ammonia. Dephenolizers for phenol recovery are installed at some plants.

Biological treatment systems are installed at many plants for wastewater treatment prior to discharge.

Some coke plants use WAL as makeup for coke quenching systems but serious operational and environmental problems arise from this usage, e.g., air pollution, carry-over of corrosive constituents in the coke to blast furnaces, and corrosion of adjacent equipment due to the mist from the quenching operation.

3.2 BLAST FURNACES - GENERAL

Iron is produced in a blast furnace by the chemical reduction of iron ore and miscellaneous iron bearing materials including sinter, enriched ore pellets, ferro-manganese ores and iron or steel scrap in various combinations. Figure 3-2 is a schematic representation of the process.

3.2.1 Manufacturing Process

The production of iron in the blast furnace is performed under pressure at high temperature under reducing conditions. Iron compounds, coke and limestone are the furnace charge. Air that has been compressed and preheated (hot blast), is injected into the lower part of the blast furnace and is required to support the combustion of the coke (and other injected fuel, e.g., oil or coal fines). As the iron compounds are reduced in the furnace, molten iron is formed and collects

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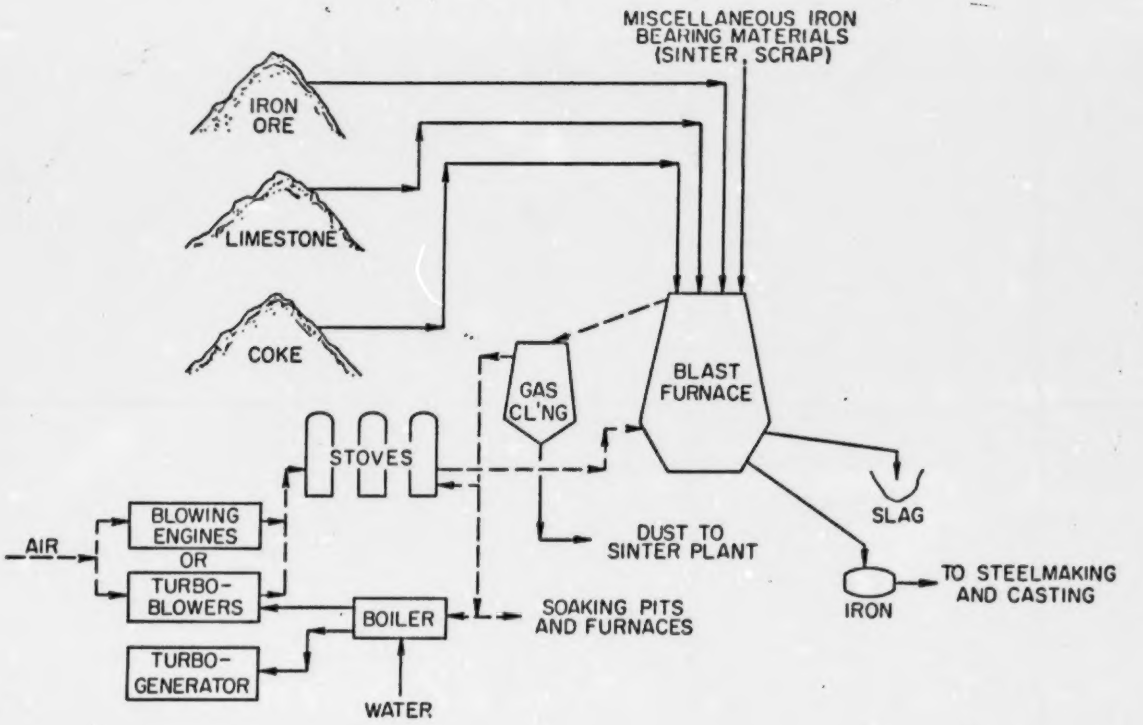
MISCELLANEOUS IRON BEARING MATERIALS (SINTER, SCRAP)
IRON ORE
LIMESTONE
COKE
BLAST FURNACE
GAS CL'NG
STOVES
BLOWING ENGINES
OR
TURBO-BLOWERS
AIR
BOILER
TURBO-GENERATOR
WATER
DUST TO SINTER PLANT
SOAKING PITS AND FURNACES
SLAG
IRON
TO STEELMAKING AND CASTING

FIGURE 3-2 TYPICAL IRON MAKING PROCESS FLOW DIAGRAM

on a bottom hearth. Molten slag, a collection of impurities, floats on the surface of the iron due to its lower density. Periodically, the slag is tapped into ladle cars and the molten iron is tapped into hct-metal cars for transport to steel making or casting facilities. The molten iron may also be cast into shapes or pigs.

Blast furnace gas (containing some carbon monoxide) is also produced. It is cleaned to remove entrained particles of iron oxide and other impurities. The gas is used to fuel the hot blast stoves, the boilers for steam and electrical generation and for reheating furnaces.

3.2.2 Water Use

Blast furnace gas first passes through a dry dust catcher where the major portion of the entrained solids are removed. The remaining solids are removed in high energy venturi scrubbers or some other type of wet gas washers, or wet electrostatic precipitators. In some plants a gas washer is followed by a wet electrostatic precipitator. The gas is also cooled either in conjunction with the gas washers or in separate gas coolers.

The scrubber water is usually treated in a settling tank, sometimes with the addition of coagulant aids, prior to discharge or recirculation. If the gas cleaning water is to be recirculated, it is usually cooled in an open cooling tower and then pumped back to the gas cleaning equipment. A portion of the water is discharged (or blown down) to control dissolved solids. Losses due to the blowdown, evaporation and entrainment in the gas are made up with water from an external source. Scrubber water usage is dependent upon the type of cleaning and cooling equipment used.

Sixty-nine blast furnaces were operating at the 21 foreign plants. Total production was 189,300 Mg (208,000 tons) of iron per day. Water usage ranged from 2.1 to 28.8 cubic meters per Mg (500 to 6900 gallons per ton) of molten iron produced and recycle rates ranged from zero to 99.7 percent. Zero recycle is defined as a system where the water is used once and then discharged. One hundred percent recycle is defined as system which reuses all water in the system; there is no blowdown. Water of course must be added to replace that lost by evaporation.

Seventeen blast furnaces are operated at the seven United States plants studied.(1) Production is approximately 26,000 Mg (28,600 tons) of iron per day at these plants. Water is used at a rate of 7.15 to 22.5 m^3/Mg (1700 to 5400 gallons per ton) for gas cleaning and cooling purposes. Recycle rates range from 30 to 97 percent.

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At many foreign blast furnace installations, the gas cleaning system blowdown is used for the quenching (liquid cooling) of molten slag. This consumptive use may eliminate a liquid discharge if blowdown does not exceed quench requirements, but the air pollution effects must be considered. Some water is removed from the system in the sludge discharged from the settling tanks. This has the effect of reducing blowdown. Sludge is conveyed to landfills, sinter plants, pelletizing plants and stockpiles.

3.3 UNITED STATES ENVIRONMENTAL PROTECTION AGENCY PROPOSED EFFLUENT LIMITATIONS GUIDELINES (1)

The United States Environmental Protection Agency has published proposed effluent limitations guidelines for all steel plant processes. They contain alternative treatment methods and effluent contaminant levels. One of each must be selected as the final BAT (Best Available Technology Economically Achievable).

The draft effluent limitations guidelines (ELG) for the "Iron and Steel Manufacturing" point source category contain alternative recommendations for by-product coke plant and blast furnace wastewater systems.

There are three proposed alternative treatment methods for by-product coke plant wastewater and five for blast furnace wastewater.

Three of the by-product coke plant systems utilize biological treatment, viz:

BIOLOGICAL TREATMENT

Alternative 1
  a. Ninety-six percent recycle of untreated barometric condenser water
  b. First stage activated sludge
  c. Clarification
  d. Second stage activated sludge
  e. Clarification
  f. Filtration

Alternative 2
  a. Ninety-six percent recycle of untreated barometric condenser water
  b. First stage activated sludge
  c. Clarification
  d. Powdered activated carbon addition
  e. Second stage activated sludge
  f. Clarification
  g. Filtration

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TABLE 3-1. USEPA PROPOSED BAT BY-PRODUCT COKE PLANT BASIC EFFLUENT LIMITATIONS (MONTHLY AVERAGES) (1)

Parameter	Alternatives 1 kg/Mg* lb/1000 lb	Alternatives 1 mg/l	Alternatives 2 kg/Mg* lb/1000 lb	Alternatives 2 mg/l	Alternatives 3 kg/Mg* lb/1000 lb	Alternatives 3 mg/l
Ammonia-N	0.00957	15	0.00957	15	No discharge of pollutants	
Total cyanide	0.00160	2.5	0.00128	2		
Phenolic compounds	0.000016	0.025	0.000016	0.025		
Benzene	0.000032	0.05	0.000032	0.05		
Naphthalene	0.000006	0.01	0.000006	0.01		
Benzo(a) pyrene	0.000013	0.02	0.000006	0.02		
Oil & grease	0.00638	10	0.0064	10		
Suspended solids	0.0128	20	0.013	20		
pH (units)	6-9		6-9			

* Average mass based on given concentration and effluent flow of 0.638 m^3/Mg of coke (153 gal/ton).

(1) Data from Development Document for Proposed Effluent Limitations Guidelines and Standards for the Iron and Steel Manufacturing Point Source Category. Vol. II. EPA 440/1-80/024-b. December 1980

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TABLE 3-2. USEPA PROPOSED BAT BLAST FURNACE EFFLUENT LIMITATIONS (MONTHLY AVERAGES) (1)

	Alternatives									
	1		2		3		4		5	
	kg/Mg* lb/1000 lb	mg/l	kg/Mg* lb/1000 lb	mg/l	kg/Mg* lb/1000 lb	mg/l	kg/Mg* lb/1000 lb	mg/l	kg/Mg* lb/1000 lb	mg/l
Ammonia as N	No discharge of pollutants		0.0146	50	0.0146	50	0.000292	1.0	0.000292	1.0
Total cyanide			0.000730	2.5	0.000730	2.5	0.000292	1.0	0.000292	1.0
Phenols			0.000876	3	0.000876	3	0.0000292	0.10	0.0000146	0.05
Chlorine (residual)**			No limit		No limit		0.000146	0.50	0.000146	0.50
Lead			0.0000876	0.30	0.0000438	0.15	0.0000730	0.25	0.0000730	0.25
Zinc			0.00131	4.5	0.0000730	0.25	0.0000876	0.30	0.0000876	0.30
Oil & grease**			0.0029	10	0.0029	10	0.0029	10	0.0029	10
Suspended solids			0.0044	15	0.0044	15	0.0044	15	0.0044	15
pH (units)			6-9		6-9		6-9		6-9	

---

* Mass based on flow shown - 0.292 m^3/Mg of iron - and given concentration (70 gal per ton of iron).

** Maximum concentration

(1) From Draft Development Document for Proposed Effluent Limitations Guidelines for the Iron and Steel Manufacturing Point Source Category. Vol. II. EPA 440/1-80/024-b. December 1980

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Alternative 3
a. Ninety-six percent recycle of untreated barometric condenser water
b. First stage activated sludge
c. Clarification
d. Second stage activated sludge
e. Clarification
f. Recycle to a quench unit

Blast furnace wastewater treatment has five alternatives to meet the BAT:

Alternative 1
Reduce blowdown and use for slag quenching.

Alternative 2
a. Reduce blowdown flow to 70 gal/ton
b. Filtration

Alternative 3
a. Reduce blowdown to 70 gal/ton
b. Add a source of sulfide
c. Filtration

Alternative 4
a. Alkaline - chlorination
b. Clarification
c. pH adjustment with acid
d. Filtration
e. Dechlorination

Alternative 5
a. Alkaline - chlorination
b. Clarification
c. pH adjustment with acid
d. Filtration
e. Dechlorination
f. Activated carbon treatment

The allowable effluent limitations for the by-product coke plant alternatives are presented in Table 3-1 and for the blast furnaces alternatives in Table 3-2.

Physical-chemical alternative 3 and biological alternative 3 for coke plant wastewaters and alternative 1 for blast furnace wastewater recommend that the blowdown from the system be used for coke or slag quenching. If this method of disposal is prohibited by EPA regulations, these alternatives cannot be considered.

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SECTION 4.0

SUMMARY OF FOREIGN PLANT VISITS

4.1 METHODOLOGY

To select the foreign steel plants for visitation, a survey of the world's plants was made utilizing published literature and in-house information. A preliminary list of 74 steel plants outside North America was prepared.(2) This list (Table 4-1) shows integrated steel plants with raw steel capacities of over one million metric tons (Mg) per year (1,102,300 English tons per year). The project's original emphasis was on by-product coke plant and blast furnace wastewater treatment in Western Europe, Oceania and the Far East and over 70 percent of the plants listed on Table 4-1 are within these geographical areas. Subsequent to the preparation of the preliminary list the geographic area of investigation was expanded to include Mexico, South America and South Africa. In addition, plants that produced iron and/or coke independent of integrated steel plants were included.

After the preliminary list was prepared, a more intensive literature search was undertaken. Persons knowledgeable in the international iron and steel industry were also contacted to determine which of the plants on the list practiced, or were most likely to practice, advanced treatment of by-product coke plant and/or blast furnace wastewaters.

Based on the extensive search, 28 plants in 15 countries were contacted. Permission was requested for visits to discuss wastewater treatment practices and philosophies and to observe the treatment facilities. This initial correspondence included the scope of work of Hydrotechnic's assignment. Invitations were received from 25 plants in 14 countries to discuss their by-product coke plant and/or blast furnace wastewater treatment practices. An invitation was received from an additional plant that does not have either of these production facilities to discuss its advanced hot and cold mill water recirculation systems. The plants from which invitations were received represent more than 20 percent of the steel production from plants that have steel capacities over 1 million Mg/yr outside of Canada, the U.S., and Eastern bloc countries.

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TABLE 4-1. PARTIAL LIST OF WORLDWIDE STEEL PLANTS

(Only mills in excess of 1×10^6 Mg/yr listed)

Country	Company	Plant (Work)	Yearly Capacity (Mg/yr) x 10^6	Coke Ovens	Blast Furnaces
AUSTRALIA	Broken Hill Pty. Co. Ltd.	Newcastle	2.2	217	4
	Aust. Iron & Steel Pty. Ltd.	Port Kembla	4.8	391	5
AUSTRIA	Voest-Alpine	Linz	2.44	Yes	5
BELGIUM	Usines Gustave Boel SA	La Louviere	1.45	135	6
	Cocherill SA	Liege I	4.25	477	12
	Cocherill SA	Marchienne	1.1	122	4
	Forges de Thy-Marcinelle et Mouceau SA	Marchienne	2.4	2 batt.	4
	SIDMAR	Gent	3.4	2 batt.	4
BRAZIL	CSM	Volta Redonda	2.5	3 batt.	3
FRANCE	Ste Metal de Normande	Mondeville	1.35	120	5
	Usionr	Dunkirk	6.4	5 batt.	4
WEST GERMANY	August Thyssen	Hamborn	5.22	5 batt.	8
	Hoesch Huttenwerke	Dortmund	5.64	?	6
	Neunkircher Eisenwerk AG	Neunkirchen	1.53	180	4
	Stahlwerke Peine-Salzgitter Ah	Salzgitter	3.2	Yes	6
	Stahlwerke Peine-Salzgitter Ah	Peine	1.7	Yes	3
	Stahlwerke Rochling-Burbach GmbH	Volklingen/Saar	2.00	222	6
	Stahlwerke Rochling-Burbach GmbH	Saarbrucken-Burbach	1.96	126	5
HUNGARY	Csepel Steel and Tube Works	Dunaryvaros	1.5	2 batt.	2
INDIA	Bokaro Steel Ltd.	Bokaro	2.74	69	3
	Hindustan Steel Ltd.	Bhilai	2.97	455	6
	Hindustan Steel Ltd.	Durgapur	1.7	312	4
	Hindustan Steel Ltd.	Rourhele	1.6	290	4
	Indian Iron & Steel Co.	Burnpur	1.3	308	4
	Tata Iron & Steel Co. Ltd.	Jamshedpur	1.9	361	6
ITALY	Italsider SpA	Taranto	6.5	270	5
	Italsider SpA	Bagnoli	2.35	150	3
	Italsider SpA	Cornigliano	2.2	176	3
JAPAN	Kawasaki Steel Corp.	Chiba	5.84	?	5
	Kawasaki Steel Corp.	Mizushima	10.26	?	4
	Kobe Steel Ltd.	Kobe	3.36	?	3
	Kobe Steel Ltd.	Imagasaki	1.25	?	2
	Kobe Steel Ltd.	Kakogawa	5.16	?	2
	Nippon Kokan KK	Fukuyama	18	493	5
	Nippon Kokan KK	Keihin/Ogishima	3.32	240	4
	Nippon Steel Corp.	Yawata	9.5	7 batt.	6
	Nippon Steel Corp.	Muroran	3.72	4 batt.	4
	Nippon Steel Corp.	Kamaishi	1.68	4 batt.	2
	Nippon Steel Corp.	Hirohata	4.46	4 batt.	4
	Nippon Steel Corp.	Nagoya	7.06	4 batt.	3
	Nippon Steel Corp.	Kimitsu	8.43	?	3
	Nippon Steel Corp.	Oita	3.95	2 batt.	1
	Sumitomo Metal Industries Ltd.	Wakayama	8.04	?	5
	Sumitomo Metal Industries Ltd.	Kashima	6.3	?	2
	Sumitomo Metal Industries Ltd.	Kokura	1.66	?	2
KOREA	Pohang Iron and Steel Co. Ltd.	Pohang			

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TABLE 4-1. PARTIAL LIST OF WORLDWIDE STEEL PLANTS (Continued)

Country	Company	Plant (Work)	Yearly Capacity $(Mg/yr) \times 10^6$	Coke Ovens	Blast Furnaces
LUXEMBOURG	Arbed	Esch-Belval	1.7	?	4
	Arbed	Differdande	2.8	?	9
	Arbed	Dudelangle	2.6	?	4
NETHERLANDS	Hoogovens IJmuiden BV	IJmuiden	6.86	2 batt.	7
POLAND	Huta im. Lenina	Cracow	2.0	12 batt.	5
RUMANIA	Combinat Siderurgie Galati	Galati	6.0	1 batt.	4
	Combinat Siderurgie Hunedora	Hunedora	2.8	4 batt.	?
SOUTH AFRICA	ISCOR	Pretoria	1.35	166	4
	ISCOR	Vanderbijlpark	1.775	278	3
	ISCOR	Newcastle	1.56	50	3
SPAIN	Altos Hornos de Vizcaya SA	Vizcaya	1.1	148	3
	Ensidesa	Aviles	2.69	300	4
	Ensidesa	Verina	2.5	45	2
SWEDEN	Norrbottens Jarnverk AB	Lulea	1.67	Yes	2
TAIWAN	China Steel Corp.	Kaohsiung	1.5	Yes	1
TURKEY	Eregli Iron and Steel Works	Eregli	1.4	Yes	2
	Isdemir	Ishenderum	1.1	69	2
UNITED KINGDOM	British Steel Corp.	Appleby-Frodingham	3.8	287	7
	British Steel Corp.	Normby Park	1	135	3
	British Steel Corp.	South Leesside	2.6	220	5
	British Steel Corp.	Ravenscraig	1.3	210	3
	British Steel Corp.	Port Talbot	2.4	310	5
	British Steel Corp.	Shotton	1.0	42	2
	British Steel Corp.	Corby	1.0	Yes	4
USSR	Chelyabinskig Met. Zavod	Chelyabinsk	3	Yes	6
	Cherepovetskiy Met. Zavod	Cherepouefs	6	?	4
	Dzerzhinsly		5	?	Yes
	Zhdanovskiy Met. Zavod Ilyich	Zhdanov	3.5	?	5
	Karaganda	Karaganda	3.5	?	4

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Itineraries were planned so that the visits would be made in three separate trips: one to Western Europe, one to Australia, Taiwan and Japan, and one to Mexico, South America and South Africa. A list of the plants is presented in Table 4-2 and their locations are shown on Figure 4-1.

Approximately one month prior to each trip, questionnaires were sent to each of the plants. It was hoped the information could be gathered ahead of time so the visiting team would not be delayed due to time consuming data gathering. The questionnaires are reproduced in this report as Appendix "A".

The information to be gathered was:

1. Volume of water applied or used per unit of production.
2. Recirculation rates
3. Treatment technologies
4. Types of wastewaters combined for treatment
5. Effect of raw material (i.e., coal and ore) on the quality and/or quantity of the wastewater.

Correlations between the sources of coal and the quality and quantity of by-product coke plant excess ammonia liquor, and the sources of ore and quality of blast furnace gas washer water were of particular interest. Data was specifically requested on effluent analyses which included parameters that are proposed to be limited in the draft U.S. EPA Effluent Limitations Guidelines for the Iron and Steel Point Source Category.

During the visits, permission was requested to analyze the wastewater for the various categories of pollutants which were of interest to EPA at the time of the survey. A list of these pollutants is in Table 4-3. Most plants agreed to participate in a sampling program.

Most questionnaires had been completed when the visiting team arrived at the mills. However, the data supplied and the method of compilation differed from plant to plant.

Discussions were held first with plant or corporate personnel on wastewater treatment operations and on treatment plant objectives. The visiting team then observed the wastewater treatment systems in operation at all but one of the plants.

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TABLE 4-2

LIST OF STEEL PLANTS AND COMPANIES VISITED

ARGENTINA	- Argentina Plant requested anonymity.
AUSTRALIA	- AI&S - Hoskins-Kembla Works BHP - Newcastle Works John Lysaght (Aust.) Ltd. - Port Kembla
BELGIUM	- SIDMAR, Gent
ENGLAND	- BSC - Orgreave Works BSC - Scunthorpe Works
FRANCE	- Pont-a-Mousson
ITALY	- Italsider-Taranto Works
JAPAN	- Kawasaki Steel - Chiba Works Kobe Steel - Kakogawa Works Nippon Kokan KK - Ogishima Works Sumitomo Metal Industries, Kashima Works
MEXICO	- Altos Hornos de Mexico
NETHERLANDS	- Hoogovens
SOUTH AFRICA	- ISCOR - Newcastle Works ISCOR - Pretoria Works ISCOR - Vanderbijlpark Works
SWEDEN	- Surahammars Bruks - Spannarhyttan Svenskt Stal - Norrbottens Jarnverk
TAIWAN, ROC	- China Steel Corp. - Kaohsiung
WEST GERMANY	- August Thyssen - Hutte - Duisburn Hoesch Huttenwerke - Dortmund Roechling - Burbach - Volklingen

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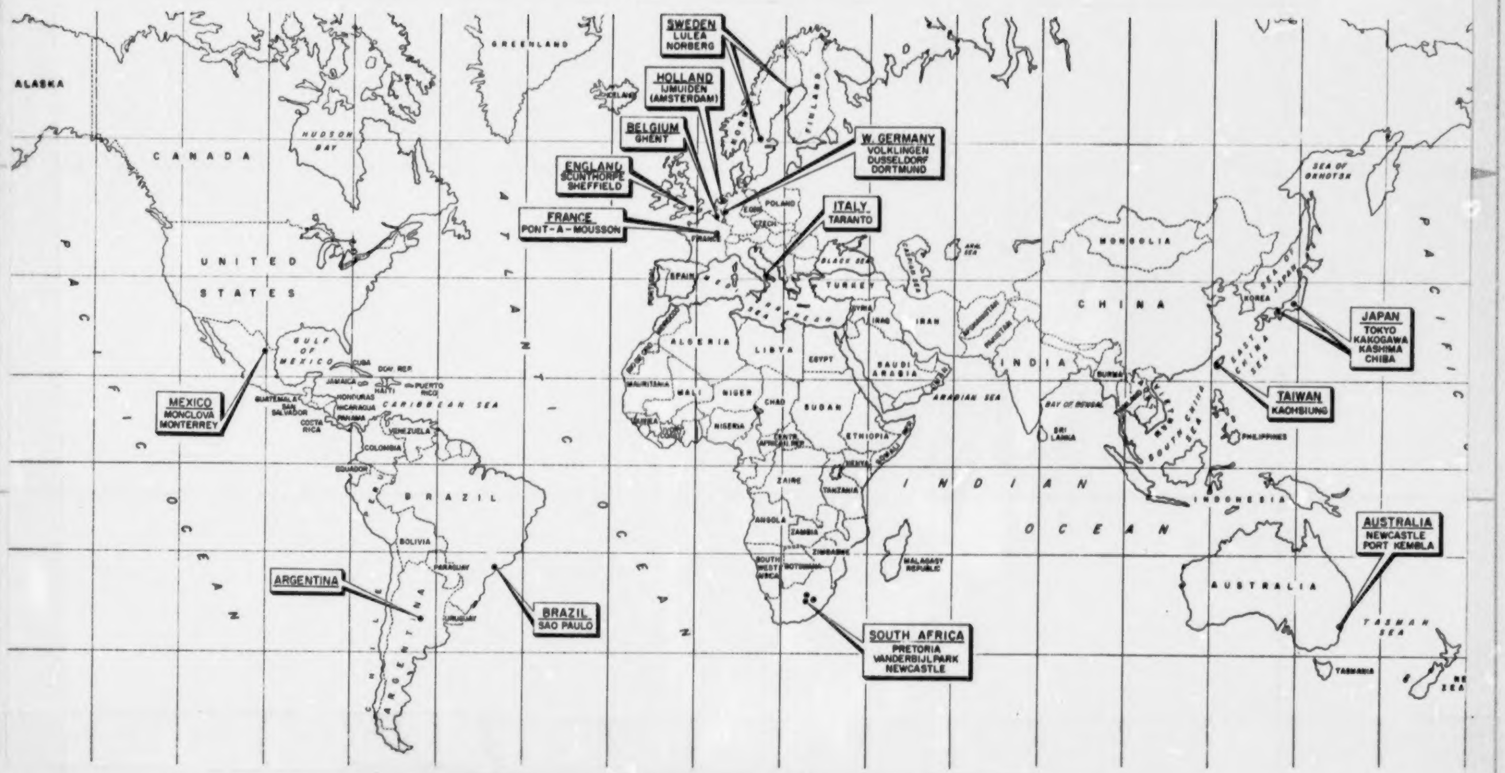
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VOLKLINGEN
DUSSELDORF
DORTMUND
ENGLAND
SCUNTHORPE
SHEFFIELD
FRANCE
PONT-A-MOUSSON
ITALY
TARANTO
JAPAN
TOKYO
KAKOGAWA
KASHIMA
CHIBA
TAIWAN
KAOHSIUNG
AUSTRALIA
NEWCASTLE
PORT KEMBLA
MEXICO
MONCLOVA
MONTERREY
ARGENTINA
BRAZIL
SAO PAULO
SOUTH AFRICA
PRETORIA
VANDERBIJLPARK
NEWCASTLE
PACIFIC OCEAN
ATLANTIC OCEAN
INDIAN OCEAN
CANADA
UNITED STATES
ALASKA
GREENLAND
HUDSON BAY
GULF OF MEXICO
CARIBBEAN SEA
BRAZIL
CHINA
INDIA
MONGOLIA
AUSTRALIA
INDONESIA
SEA OF OKHOTSK
TASMAN SEA
ARABIAN SEA
BAY OF BENGAL
SOUTH CHINA SEA

FIGURE 4-1 WORLD MAP SHOWING LOCATIONS OF PLANTS VISITED

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TABLE 4-3. POLLUTION PARAMETERS OF CONCERN IN THE U.S. EPA DRAFT EFFLUENT GUIDELINES FOR THE IRON AND STEEL INDUSTRY*

At Both** By-Product Coke Plants & Blast Furnace	At By-Product Coke Plants only	At Blast Furnaces only
	Conventional Pollutants	
Suspended Solids	Oil & Grease	-
	Non-Conventional Pollutants	
Ammonia	Total Cyanide	Cyanide amenable to chlorination
Sulfides	Phenolic Compounds	Fluoride
	Thiocyanates	
	Priority Pollutants	
Chloroform	Acrylonitrile	2-4 Dichlorophenol
Fluoranthene	Benzene	2-4 Dimethylphenol
Naphthalene	Ethylbenzene	Hexachlorobenzene
Phenol	Phthalates (total)	Phthalates:
Benzo(a)pyrene	Benzo(a)anthracene	bis(2-ethylhexyl) -
Fluorene	Acenaphthylene	Butyl benzyl -
Pyrene	Toluene	Di-n-butyl -
Antimony	Xylene	Di-n-octyl -
Arsenic		Diethyl -
Selenium		Dimethyl -
Silver		Chrysene
Zinc		Cadmium
		Chromium
		Lead
		Nickel
		Copper

* From "Draft Development Document for Proposed Effluent Limitations Guidelines and Standards for the Iron and Steel Manufacturing Point Source Category", Vols. II & III EPA 440/1-79/024a October 1979.

** pH is included as a parameter to be controlled under conventional pollutant category.

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SECTION 5.0

WASTEWATER TREATMENT TECHNOLOGY AT BY-PRODUCT COKE PLANTS AND BLAST FURNACES IN THE UNITED STATES

Data for U.S. by-product coke plant and blast furnace wastewater treatment technology were collected so a comparison could be made with foreign technology to determine which was more advanced. This information was obtained from the U.S. EPA Draft Effluent Limitations Guidelines Development Documents. These contain data on wastewater treatment facilities for most steel plants in the United States.

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5.1 COKE PLANT WASTEWATER TREATMENT

Data are available for 60 of the 67 coke plants in the United States with a total average daily production of approximately 153,300 Mg (169,000 tons). The average flow of raw wastewater, including waste ammonia liquor (WAL), final cooler condensate, and ammonia still wastes, is about 0.91 m^3/Mg (217.6 gpt) of coke produced.(1)

Processes utilized for the treatment of coke plant wastewater are summarized on Table 5-1. The most common is the free ammonia still where free ammonia is stripped from the waste ammonia liquor with steam. Free ammonia stills are, in many cases, followed by a fixed ammonia still where ammonia that is combined with an anion, usually chloride or sulfate, is stripped under alkaline conditions. Only three plants (owned by the same corporation and comprising 8.9 percent of the total nationwide coke production) utilize fixed ammonia stills which are not preceded by free stills. At these three plants, the wastewater is further treated in a biological treatment plant. Two other plants treat their wastes by alkaline chlorination. One plant has free and fixed ammonia stills; the other does not strip ammonia. One plant discharges the treated wastes to a publicly owned treatment works (POTW). The second passes the wastes through an activated carbon adsorption tower. Part of the treated wastes are used for coke quenching. The balance is discharged. Two coke plants, both at the same steel plant, use free and fixed ammonia stills followed by activated carbon adsorption. The treated wastewater is then discharged directly or used for quenching. Two plants pump portions of their untreated wastewater into deep wells. The balance is used for quenching coke.

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When the team returned to the United States, trip reports describing the systems were prepared, which included the operational and analytical data from the questionnaires and conversations. These reports were then sent to the respective plant for verification. The verified reports were then used to analyze the wastewater treatment system operation in detail. Treatment methods observed at the plants in Western Europe and the Far East were compared with those installed at certain blast furnaces and coke plants in the United States. In addition, the effluent analyses containing the data on regulated substances were compared to the effluent analyses at some United States blast furnace and coke plant wastewater treatment facilities.

To understand the reasons for the selection of various treatment systems the regulating agencies of most of the countries involved were contacted. Requests were made to the agencies for meetings to discuss the steel industry regulations. Ten of twelve countries agreed to discuss the regulations and the methods used to establish them.

The original scope of work called for subsequent trips to selected exemplary foreign treatment plants so that raw and treated wastewater could be analyzed to determine reductions in conventional, non-conventional and priority pollutants. After consultation with EPA before any trips were made, it was decided that the probability of any of these plants having exceptional pollutant reductions was minimal. The project alternatives would be better served by observing additional foreign plants with emphasis on plants using high reuse/recycle rates. On this basis, a trip was made to Mexico, South America and South Africa.

4.2 SUMMARY OF FOREIGN PLANT TRIP REPORTS

Detailed trip reports of 23 of the 26 plants visited are included as Appendix B. It contains data reviewed and corrected by plant personnel and which have been summarized in Tables 4-4, 4-5, 4-6, 4-7 and 4-8.

Trip reports were not prepared for three plants. Two plants, one near Sao Paulo, Brazil, and one in Monterrey, Mexico, did not have the data requested in the questionnaires when the visits were made. Attempts were made during the visits to obtain the information but the plant personnel said that the questionnaires would be completed and sent by mail. Upon completion of the trips and after repeated requests, the data were still nor forthcoming. Conversations with plant personnel and observations during the visit indicated that the plant in Mexico settles all and recirculates a part of its blast furnace gas washer wastewater and the plant in Brazil

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TABLE 4-4. SUMMARY OF FOREIGN BY-PRODUCT COKE PLANT PRODUCTION AND WASTEWATER TREATMENT METHODS (Sheet 1 of 6)

Country/ Plant	No. of Batteries (ovens) / Production Mg/day	Quench Water Source	Quench Water Application Rate / Loss Rate m3/Mg	Volume of WAL Produced m3/Mg	Total Waste Flow & Sources m3/hr	Treatment	Notes
ARGENTINA							
	4(165) 3472	NA	NA 1-1.4	NA	NA	FAS, FXAS.	Discharged to river.
AUSTRALIA							
Hoskins Kembla Port Kembla	5(401) 8365	Charging scrubbers Water seal standpipe Stripped WAL Benzol Plant fresh water	- 0.086 - 0.31 - 0.155 - 0.278 - 0.25 Applic.6 1	0.15	NA	None	
BHP Newcastle	4(192) 4000	Still bottom final cooler condenser, coke battery leaks benzol plant, tar tank farm recovered fresh water, emission control fresh water	- 0.222 - 0.030 - 0.030 - 0.090 - 0.001 - 0.132 - 0.035 Applic.NA 0.63	0.18	NA	FAS	All wastes used to quench coke
BELGIUM							
Sidmar	2(100) 2500	Canal	2.57 0.94	0.14	25 from FAS	FAS, settling (10 hrs), aeration (3 hrs), settling (2½ hrs), aeration (23 hrs), settling (10 hrs). NaH_2PO_4 and $FeSO_4$ added.	Quench makeup water has Cl of 4000-5000 mg/l. Causes corrosion in system and in blast furnace gas cleaning system. F is also a problem. Cold mill wastes sprayed at 1 m^3 prior to quench. Use will be discontinued due to evidence of organics in the air and oil in the mist. Phenol removal noted in the FAS. Optimum temp. for aeration system is 25-30^oC. When NH_3 is over 1000 mg/l dilution water is added to ratios as high as 3:1 Future plans are to revise recirculation system and add a FXAS (3).

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TABLE 4-4. SUMMARY OF FOREIGN BY-PRODUCT COKE PLANT PRODUCTION AND WASTEWATER TREATMENT METHODS (Sheet 2 of 6)

Country/ Plant	No. of Batteries (ovens) / Production Mg/day	Quench Water		Volume of WAL Produced m3/Mg	Total Waste Flow & Sources m3/hr	Treatment	Notes
		Source	Application Rate / Loss Rate m3/Mg				
BELGIUM/ Sidmar (Cont'd)							Total wastes to be treated will be 46 m^3/hr with a discharge quality of: pH 6.5-9 Phenol (tot) 5 BOD$_5$ 67 CN$_A$ 1 COD 335 F 5 NH$_4$-N 250 S(H$_2$S) 5
ENGLAND							
Orgreave	2(86) / 1243	R. Rother via the barometric condenser	1.3 / 0.43	1.63	54.5; 31.8 from coke plant, 4.5 from quench, 18.2 from tar plant.	FAS, FXAS, Equalization (10 days), 2 parallel aeration basins, one clarifier. Sizes not provided.	Sludge is lagooned and decant water returned to aeration. Quality of quench and tar plant water not known therefore actual dilution cannot be determined. Plant is being urged to discharge their treated wastes to the municipal treatment plant.
Scunthorpe	3 plants: 5(170) 4(135) 4(135) 3555	Recovered drainage and river	14.3 / 0.55	0.26	67 WAL, cooling system blowdown & benzol recovery distillates	FAS, FXAS, Equalization (24 hr), aeration (22 hrs) in 3 sets of 3 aeration basins (total of 9). Flow is divided in 3 and each 1/3 is aerated and settled in its own set of basins and thickener. PO$_4$ is added as well as pH adjustment chemicals as needed. Dilution ratio of fresh water to waste is 2.4:1. Treated wastes are stored in a 3200 m^3 reservoir and discharged during 4-hour periods coincident with high tides in the River Trent to achieve maximum dispersion and minimum retention in the tidal reaches of the river.	Sludge is thickened to 3% solids and lagooned. Supernatant returned to aeration.
FRANCE							
Pont-a-Mousson (4)	2(48) / 800-900	Mosell R. & Pushing scrubber blowdown	NA / 0.6	0.19	8	FAS, FXAS, H$_2$SO$_4$ neutralization. Addition of FeSO$_4$ and H$_3$PO$_4$. Aeration and settling.	Quenching will be by steam pressure quenching. Pushing dust control will use ERIN system. Biological system expected to use dilution water to waste ratios of 1.6:1 to 2.5:1.

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TABLE 4-4. SUMMARY OF FOREIGN BY-PRODUCT COKE PLANT PRODUCTION AND WASTEWATER TREATMENT METHODS (Sheet 3 of 6)

Country/ Plant	No. of Batteries (ovens) / Production Mg/day	Quench Water Source	Quench Water Application Rate / Loss Rate m^3/Mg	Volume of WAL Produced m^3/Mg	Total Waste Flow & Sources m^3/hr	Treatment	Notes
ITALY							
Taranto	10 (430) 13,700	River	NA NA	NA(1)	NA	FAS(2); 3 parallel aeration basins, clarifiers, thickeners. When FAS not operating, dilution water added at 1:1 ratio, 98% H_3PO_4 added (8 l/day which is increased when pH in basins is above 8.2).	Approx. 75 m^3/day of sludge dewatered in vacuum filters and disposed of in landfill. Treated wastes combined with all other wastes, including once-through salt cooling water, and discharged to Gulf of Taranto. Total plant flow is 70,000 m^3/hr.
JAPAN							
Kawasaki Steel Chiba Works	10(402) 8070	Indirect cooling blowdown charging and pushing scrubber blowdown	NA 1.04	0.29	95.8	FAS, coke filter, preaeration with H_2SO_4 added for pH control. H_3PO_4 added, aerated (33 hrs). Clarifier with addition of 100 mg/l, $FeCl_3$. 50 mg/l $Ca(OH)_2$, 0.2 mg/l polyelectrolyte. Sedimentation basin (4.4 hrs retention and overflow rate of 22 $m^3/m^2/hr$), activated carbon (13.2 $m^3/m^2/hr$).	Biological system operated at: Temp 24-34°C DO 1-3 mg/l pH 7.0-7.2 MLSS 5000-6000 mg/l Filter backwash discharged to sedimentation basin. Dilution water is sea water added at a ratio of 1:1. Clarifier and sedimentation sludge is dewatered. Treated wastes discharged to Tokyo Bay.
Kobe Steel Kakogawa Works	2(228) 7500	Kakogawa River	2.6 0.4	0.2	63-75	Equalization (1 day). Aerated in 3 of 6 basins (estimated at 15 hrs). Settled filtered in pressure filters (rate is 15 $m^3/m^2/hr$). H_3PO_4 added at rate of 0.6 mg per 100 mg/l BOD for nutrient. pH control by addition of H_2SO_4.	Solids dewatered in a dual cell concentrator. Dilution water added at a ratio of 1:1. Two of the aeration basins are covered. Surface aerators are used in all basins. Treatment plant is part of coke and by-product plant owned and operated by the Kansai Coke and Chemical Co. on Kakogawa Works site. Plant designed by Shinko-Pfaudler Co., Ltd.
Nippon Kokan	1(124) 5750	Dry Quenching		0.15-0.2 (m^3/kkg of coal coked)	50-54	FAS, FXAS, Equalization (2 days), H_2SO_4 for pH control and H_3PO_4 for nutrients added, aeration (1-2 days), thickener $FeCl_3$ and polyelectrolyte added in coagulation-sedimentation tank gravity sand filter, activated carbon.	Ammonia sold to NKK Fertilizer Div. Tars injected into blast furnaces. Crude oil sold. Sludge is dewatered and burned. Treated wastes discharged to Tokyo Bay. Pushing emissions controlled by venturi and wet electrostatic precipitator. Charging emissions controlled by venturi. Total water use is 380 m^3/hr. Water is recirculated after settling. Solids go to sinter plant. Water blowdown is 1200 m^3/day to Tokyo Bay.

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TABLE 4-4. SUMMARY OF FOREIGN BY-PRODUCT COKE PLANT PRODUCTION AND WASTEWATER TREATMENT METHODS (Sheet 4 of 6)

Country/ Plant	No. of Batteries (ovens) / Production Mg/day	Quench Water		Volume of WAL Produced m^3/Mg	Total Waste Flow & Sources m^3/hr	Treatment	Notes
		Source	Application Rate / Loss Rate m^3/Mg				
JAPAN (Cont'd)							
Sumitomo Metal Ind. Kashima Works	7(292) 7000	Fresh	NA NA	NA	NA	FAS, FXAS, Equalization 2 parallel activated sludge systems with settling	Coke oven gas is desulfurized by FUMAKS method. Gas is further washed to remove CN, CNS and NH_4. Wash water is passed through a separate FAS. NH_4 from all stills is incinerated. Dilution water is added in equalization. Treated wastes combined with other wastes and a large volume of cooling water and discharged to the Pacific Ocean.
MEXICO							
Altos Hornos	4(218) 2100	WAL, Plant water supply reverse osmosis reject, misc. plant wastes lagcon.	NA 0.83	0.14	12.5	FAS.	No discharge from coke plant to public waters.
NETHERLANDS							
Hoogovens	11(339) 6800	River	NA 2.5	0.14	70 from FAS	FAS; addition of: HCl waste pickle liquor, 5 kg/day 100% NaOH, 3.1/hr 100% H_3PO_4. Mixed in 1500 m^3 aeration basin by 4 surface aerators. Settled in a 200 m^2 settling tank with addition of waste pickle liquor. Sludge recycled and excess discharged with treated wastes.	Treatment plant operating parameters are: MLSS 3000 mg/l, pH 7-8, temp. 30-35°C, D.O. 0.5-1 mg/l. D.O. variations are indicative of upsets in by-product plant operations. During upsets biological plant is by-passed. When temperature of biological system rises above 37°C, efficiency drops off. Above 45°C phenol degradation is approximately 60%.
SOUTH AFRICA							
ISCOR-Pretoria Works	4(160-166) 2800	All coke and by-product plant wastes Others	0.5 NA 0.62	0.25	NA	FAS.	All wastes disposed of by quenching.
Newcastle Works	4(200) 1500	WAL Seal water Used industrial water	NA 1.5	0.74	NA	FAS, H_2S stripping	All wastes disposed of by quenching.

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TABLE 4-4. SUMMARY OF FOREIGN BY-PRODUCT COKE PLANT PRODUCTION AND WASTEWATER TREATMENT METHODS (Sheet 5 of 6)

Country/ Plant	No. of Batteries (ovens) / Production Mg/day	Quench Water: Source	Quench Water: Application Rate / Loss Rate m^3/Mg	Volume of WAL Produced m^3/Mg	Total Waste Flow & Sources m^3/hr	Treatment	Notes
SOUTH AFRICA (Continued)							
Vanderbijl-park Works	7(385) / 7840	Blast furnace gas cleaning blowdown, $(NH_4)_2SO_4$ mfg. blowdown, industrial water.	NA / 0.3	NA	Excess wastes over volume required for quench makeup $(NH_4)_2SO_4$ Mfg. Nos. 1&2 - 20 No. 3 - 140	Holding pond then pumped to irrigation of grass area.	No discharges to public waters.
SWEDEN							
Svensk Stal Norbottens Jarnverk	1(54) / 2000	River and treated coke plant wastes	NA / 1.9	0.48	40	FAS; H_2S still; equalization where 6 l/m concentrated H_3PO_4 and 20% $FeSO_4$ are added. pH control between 6.5 & 8 is by addition of H_2SO_4 or NaOH. Complete mix activated sludge with 24 hour detention. Basin is covered to maintain temperature	
TAIWAN							
China Steel Kaohsiung	1(78) / 2403	Blast furnace bottom spray blowdown	1.5 / 0.6	0.2-0.3	WAL: 20-30 Benzol plant: 20 Sanitary: 20	WAL through FAS, WAL & benzol plant through coke filter, sanitary through comminutor & degritter. Combined flow through activated sludge (17 hrs aeration). Clarified, chlorine contact (15 mins.).	Treated wastes to industrial lagoon which overflows to Kaohsiung second sea harbor. Sludge dewatered in a belt filter press, mixed with inorganic solids and sold to a cement company.
WEST GERMANY							
Roechling Burbach Volklingen	4(172) / 2000	Saar River	NA / NA	0.18-0.24	NA	FAS, Dephenolization by ether extraction	Treated wastes combined with sanitary sewage and used to granulate slag.
Burbach	NA / NA	NA	NA / NA	NA	12.5	FAS, single stage activated sludge. Approx. 9 hour detention. H_2SO_4, $FeSO_4$, H_3PO_4 and antifoamant added. Dilution ratio of fresh water to waste is 3:1.	Sludge discharged to dump.
Neunkirchen & Dillingen	NA / NA	NA	NA / NA	NA	NA	FAS, single stage activated sludge. $FeSO_4$ and H_3PO_4 added. Dilution ratio of fresh water to waste is 1:1 to 1:2.	Sludge is dewatered and dumped.

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TABLE 4-4. SUMMARY OF FOREIGN BY-PRODUCT COKE PLANT PRODUCTION AND WASTEWATER TREATMENT METHODS (Sheet 6 of 6)

Country/ Plant	No. of Batteries (ovens) / Production Mg/day	Quench Water		Volume of WAL Produced m³/Mg	Total Waste Flow & Sources m³/hr	Treatment	Notes
		Source	Application Rate, / Loss Rate m³/Mg				
WEST GERMANY (cont'd)							
Thyssen ATH	5(294) / 8800	Pushing, charging & screening air pollution control wet-scrubber	NA / 0.56	0.62	228	Dephenolizer and FAS.	Discharge together with blast furnace and power house cooling blowdown is discharged to the Emscher River. River also receives other industrial wastes. Entire river is diverted and treated prior to return to flow to Ruhr River.

NOTES:

(1) Not Available
(2) FAS is Free Ammonia Still
(3) FXAS is Fixed Ammonia Still
(4) Description of Pont-a-Mousson is for future operations after planned modifications are completed.

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TABLE 4-5. U.S. VERSUS FOREIGN BY-PRODUCT COKE PLANT WASTEWATER TREATMENT PERFORMANCE - RAW WASTEWATER (Sheet 1 of 2)

Country/ Plant	Raw Flow Treated m^3/Mg	Dilution Ratio Dil.: Waste	pH	SS		CN		CNS		Oil & Grease		Phenol		Ammonia		Sulfide	
				mg/l	kg/Mg	mg/l	kg/Mg	mg/l	kg/Mg	mg/l	kg/Mg	mg/l	kg/Mg	mg/l	kg/Mg	mg/l	kg/Mg
U.S.																	
Biolog.	0.909	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Phys-Chem.	0.909	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
ARGENTINA (8) -	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
AUSTRALIA																	
Newcastle (6)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Hoskins Kembla	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
BELGIUM																	
Sidmar	0.17	0-3:1	7.8	x	x	3.72	6.32×10^{-4}	84.2	1.43×10^{-2}	x	x	100	1.7×10^{-2}	527	8.96×10^{-2}	x	x
ENGLAND																	
Scunthorpe	0.45	2.4:1	7.8	105	4.73×10^{-2}	13	5.85×10^{-3}	120	5.4×10^{-2}	x	x	900	4.05×10^{-1}	140	6.3×10^{-2}	x	x
Orgreave	1.05	0	x	x	x	10	1.05×10^{-2}	400	4.2×10^{-1}	x	x	300	3.15×10^{-1}	120	1.26×10^{-1}	x	x
FRANCE																	
Pont-a-Mousson (5)	0.23	1.6-2.5:1	6.8-8.5	32	1.92×10^{-2}	22	1.32×10^{-2}	x	x	x	x	2200	1.32	200-400	$1.2\text{-}2.4 \times 10^{-1}$	x	x
ITALY																	
Taranto	x	1:1	8.7	x	x	98	1.4×10^{-1}	x	x	x	x	510	7.6×10^{-1}	1010	1.5	x	x
JAPAN																	
Kobe	0.2	1:1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Sumitomo	x	x	x	10	x	20-25	x	x	x	x	x	1500	x	x	x	x	x
Kawasaki	0.29	1:1	9	x	x	x	x	x	x	x	x	200-300	$5.8\text{-}8.7 \times 10^{-2}$	x	x	x	x
NKK	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
MEXICO																	
Altos Hornos	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
NETHERLANDS																	
Hoogovens	0.247	0	5.5	x	x	1-10	2.47×10^{-4} to 2.47×10^{-3}	x	x	x	x	400-700	$9.88\text{-}17.3 \times10^{-2}$	1000-1800	$2.47\text{-}4.45 \times 10^{-1}$	5-10	$1.24\text{-}2.4 \times 10^{-3}$

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TABLE 4-5. U.S. VERSUS FOREIGN BY-PRODUCT COKE PLANT WASTEWATER TREATMENT PERFORMANCE - RAW WASTEWATER (Sheet 2 of 2)

Country/ Plant	Raw Flow Treated m^3/Mg	Dilution Ratio Dil.: Waste	pH	SS mg/l	SS kg/Mg	CN mg/l	CN kg/Mg	CNS mg/l	CNS kg/Mg	Oil & Grease mg/l	Oil & Grease kg/Mg	Phenol mg/l	Phenol kg/Mg	Ammonia mg/l	Ammonia kg/Mg	Sulfide mg/l	Sulfide kg/Mg
S. AFRICA																	
Pretoria (6)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Newcastle (6)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Vanderbijl-park (9)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
SWEDEN																	
Svensk Stal Norbottens Jarnverk	.48	0	7.8	x	x	0.2-0.3	9.6-14.4 x 10^{-5}	100-200	4.8-9.6 x10^{-2}	x	x	500-600	2.4-2.88 x 10^{-1}	900-1000	4.32-4.8 x 10^{-1}	0.18-0.27	8.64-129 x 10^{-5}
TAIWAN																	
China Steel Kaonsiung	0.4	0	8.9	40-50	1.6-2 x 10^{-2}	10	4x10^{-3}	x	x	10	4x10^{-3}	500	2x10^{-1}	600-700	2.4-2.8 x 10^{-1}	x	x
W. GERMANY																	
Volklingen (2)	0.18-0.24	x	8.[illegible]	x	x	161	2.9x10^{-2}	x	x	x	x	613	1.1x10^{-1}	6600	1.19	480	8.64x x 10^{-2}
Burbach (3)	x	3:1	x	x	x	4.7	x	x	x	x	x	1143	x	3678	x	x	x
Neunkir-chen (3)	x	1:2	9.[illegible]	x	x	43	x	x	x	x	x	400-600	x	1500	x	118	x
Thyssen (4)	0.62	0	8.3	19	x	.022	x	x	x	x	x	0.2	x	261	x	x	x

NOTES:

(1) Data presented is the better of two values provided.

(2) Treated wastes discharged from slag quench with sanitary wastes. Mass calculated on lower dilution.

(3) Flows and masses not available due to lack of production data.

(4) After free ammonia still wastes are stripped of phenol and discharged. No discharge data available.

(5) Expected results from a plant under construction. Masses calculated on lower dilution.

(6) No treatment beyond fixed ammonia still. All wastes used to quench coke.

(7) Includes sanitary wastes requiring treatment.

(8) Discharge to river after fixed ammonia still.

(9) Excess wastes used to irrigate grass crop.

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TABLE 4-6. U.S. VERSUS FOREIGN BY-PRODUCT COKE PLANT WASTEWATER TREATMENT PERFORMANCE - TREATED WASTEWATER (Sheet 1 of 2)

Country/ Plant	Flow Dis- charged m3/Mg	pH	SS		CN		CNS		Oil & Grease		Phenolic		Phenol		Ammonia		Sulfide	
			mg/l	kg/Mg	mg/l	kg/Mg	mg/l	kg/Mg	mg/l	kg/Mg	mg/l	kg/Mg	mg/l	kg/Mg	mg/l	kg/Mg	mg/l	kg/Mg
U.S.																		
Biolog.	0.638	6-9	20	1.28×10^{-2}	2.5	1.6×10^{-3}			10	6.38×10^{-3}	0.025	1.6×10^{-5}			15	9.57×10^{-3}		
ARGENTINA (8) -	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
AUSTRALIA																		
Newcastle (d)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Hoskins Kembla	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
BELGIUM Sidmar	0.17-0.68	7.4	x	x	0.62	1.05×10^{-4}	5.87	9.98×10^{-4}	x	x	x	x	1.02	1.73×10^{-4}	340	5.78×10^{-2}	x	x
ENGLAND																		
Scunthorpe	1.54	x	x	x	0.89	1.37×10^{-3}	16	2.46×10^{-2}	x	x	x	x	18	2.77×10^{-2}	571	8.79×10^{-1}	x	x
Orgreave	1.05	x	x	x	x	x	x	x	x	x	x	x	2	2.1×10^{-3}	200	2.1×10^{-1}	x	x
FRANCE Pont-a-Mousson (5)	0.6-0.81	6.5-8.5	30	1.8×10^{-2}	x	x	x	x	20	1.2×10^{-2}	x	x	0.2	1.2×10^{-4}	200-400	$1.2\text{-}2.4 \times 10^{-1}$	x	x
ITALY Taranto	1.49 (1)	7.8	22	3.3×10^{-3}	1.2	1.79×10^{-3}	x	x	x	x	x	x	2.0	2.98×10^{-3}	1010	1.5	x	x
JAPAN																		
Kobe	0.4	x	x	x	0	0	0	0	0	x	x	x	x	x	x	x	x	x
Sumitomo	x	x	40	x	2	x	x	x	x	x	x	x	trace	x	x	x	x	x
Kawasaki	0.57	7	<10	$<5.7 \times 10^{-3}$	x	x	x	x	x	x	x	x	< 0.2	$<1.14 \times 10^{-4}$	x	x	x	x
NKK	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
MEXICO																		
Altos Hornos (9)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
NETHERLANDS Hoogovens	0.247	7.8	x	x	1	2.47×10^{-4}	x	x	x	x	x	x	x	x	1000-1800	$2.47\text{-}4.45 \times 10^{-1}$	5	1.24×10^{-3}
S. AFRICA																		
Pretoria (8)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Newcastle (8)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Vanderbijlpark (12)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

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TABLE 4-6. U.S. VERSUS FOREIGN BY-PRODUCT COKE PLANT WASTEWATER TREATMENT PERFORMANCE - TREATED WASTEWATER (Sheet 2 of 2)

Country/ Plant	Flow Dis-charged m^3/Mg	pH	SS		CN		CNS		Oil & Grease		Phenolic		Phenol		Ammonia		Sulfide	
			mg/l	kg/Mg	mg/l	kg/Mg	mg/l	kg/Mg	mg/l	kg/Mg	mg/l	kg/Mg	mg/l	kg/Mg	mg/l	kg/Mg	mg/l	kg/Mg
SWEDEN																		
Svensk Stal Norbottens Jarnverk	0.48	7.4	x	x	0.14	6.72×10^{-5}	x	x	x	x	x	x	0.3	1.44×10^{-4}	1350	6.48×10^{-1}	x	x
TAIWAN																		
China Steel Kaonsiung	$0.6^{(9)}$	8	<60	3.6×10^{-2}	0.18	1.08×10^{-4}	x	x	7.5	4.5×10^{-3}	x	x	0.5	3×10^{-4}	$360^{(10)}$	2.16×10^{-1}	x	x
W. GERMANY																		
Volklingen (3)	(4)	7.5-8.0	38-81	9.12-19.4 x 10^{-3}	0.042-0.245	1.01-5.88 x 10^{-5}	x	x	0.02-3.8	4.8-91.2 x 10^{-5}	x	x	0.02-0.28	4.8-67.2 x 10^{-6}	15-27.7	3.6-6.65 x 10^{-3}	x	x
Burbach (5)	x	x	x	x	0.34	x	x	x	x	x	x	x	.06	x	820	x	x	x
Neunkirchen (6)	x	8.5	x	x	0.16-1.01	x	x	x	x	x	x	x	2.9-5.3	x	x	x	0.4-1.9	x
Thyssen (7)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

NOTES

(1) Design flow

(2) Data presented is the better of two values provided.

(3) Treated wastes discharged from slag quench with sanitary wastes. Mass calculated on higher flow in discharge and lower in raw.

(4) Waste disposed of by slag granulation.

(5) Flows and masses not available due to lack of production data.

(6) Flows and masses not available due to lack of production data.

(7) After free ammonia still wastes are stripped of phenol and discharged. No discharge data available.

(8) No treatment beyond fixed ammonia still. All wastes used to quench coke.

(9) Includes sanitary wastes requiring treatment.

(10) Fixed ammonia.

(11) Discharge to river after fixed ammonia still.

(12) Excess wastes used to irrigate grass crop.

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TABLE 4-7. SUMMARY OF FOREIGN BLAST FURNACE PRODUCTION AND WASTEWATER TREATMENT METHODS (Sheet 1 of 5)

Country/ Plant	No. of Blast Furnaces/ Production (Mg/day)	Gas Cleaning System	Vol. of Water Applied (m^3/Mg)	Source of Makeup	Gas Washer Water Treatment	Percent Recycle	Blowdown to	Notes
ARGENTINA								
	2/ 1 @ 2800 1 @ 3100	2 Venturis, washers	8.1	Filtered river water	Thickener	0	River	Solids to thickener underflow to pond. Solids eventually to sinter plant.
AUSTRALIA								
Hoskins-Kembla	5 (4 operating)/			Bay (salt water)				
	1 @ 2400	Orifice, Brassert, WESP	8.5		Thickener overflow rate 3 $m^3/m^2/hr$. Sludge to BF 4 thickener.	0	Inner Harbor	
	1 @ 2700	Venturi Brassert, WESP						
	1 @ 3000 (BF 4)	Brassert, WESP	6		Thickener wastes from sinter plant, sludge from thickener No. 1, BOS thickener & BF5 reactor clarifier. (Overflow rate: 1.6 $m^3/m^2/hr$). Lime & polymer added. Sludge to final thickener.	0	Allens Creek	
	1 @ 5100 (BF 5)	Venturi, WESP	2.1	Bay (salt water)	Lime, polymer added in reactor-clarifier (overflow rate: 0.95 $m^3/m^2/hr$).	0	Slag quench. Quench overflow to Allens Creek	Soluble zinc in slag pit overflow is 0.2.
BHP Newcastle	4/ 1 @ 930 1 @ 1230 1 @ 1370 1 @ 2200	Brassert Washer & WESP Orifice & WESP	6.4	Air compressor, scale pits from once-through mills, fresh water	Lime to raise pH to 8.5. Polyelectrolyte, sinter plant wastes added (~163 m^3/hr). Thickener (overflow rate of 1.8 $m^3/m^2/hr$), cooled.	89.5	Sludge ponds as thickener underflow	Solids to sludge ponds. No Zn or Pb noted in groundwater around sludge ponds.
BELGIUM								
Sidmar	2/ A @ 3800 B @ 3700	Bischoff scrubber, venturi and ESP	BFA 7.4 BFB 7.1	Ghent-Ternenzen Canal	Clarifier	BFA 27.4 BFB 31.8	Reservoir to canal	Solids to lagoon. Approx. 400 m^3/hr is withdrawn from reservoir to quench slag. Future plans are to use polyelectrolyte to aid settling and lower SS in discharge.

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TABLE 4-7. SUMMARY OF FOREIGN BLAST FURNACE PRODUCTION AND WASTEWATER TREATMENT METHODS
(Sheet 2 of 5)

Country/ Plant	No. of Blast Furnaces/ Production (Mg/day)	Gas Cleaning System	Vol. of Water Applied (m^3/Mg)	Source of Makeup	Gas Washer Water Treatment	Percent Recycle	Blowdown to	Notes
ENGLAND								
Scunthorpe Apex furnaces	2/ 2590	1 Orifice, 5 washers, 4 WESP 4 disintegrators	12.6	59% softened river water. 41% blast furnace cooling	3 clarifiers	98.6	Treatment system then to River.	Solids to lagoon then dredged and deposited in worked out ore mines. Supernatant from Clarifiers Apex / Seraphim / Redbourn / Normanby pH 8.3 8.3 8.2 7.6 SS 50 55 50 100 TDS 10000 10000 10000 3200 Hard. (tot) 1000 1000 600 900 Cl 1300 1500 1000 500 CN 10 10 10 5 CNS 70 60 50 15 F 60 70 70 20 Zn 5 15 5 10 Pb 0.8 1 0.4 0.4
Seraphim furnaces	2/ 3110	3 Orifice 3 washers 7 WESP	13.3	83% sewage 17% turboblowers	3 clarifiers	98.2		
Redbourn furnaces	3/ 1166	6 washers 6 WESP	28	softened river water	2 clarifiers	98.4		
Normanby furnaces	3/ 1 @ 9000 2 @ 3000-6000	6 washers 6 WESP	14	settled river water	3 clarifiers	95		
					Blowdown from Apex & Seraphim. Settling lagoon supernatant & BOF gas cleaning syst. Alk. chlorin., sand filtr., pH adjustment with H_2SO_4. Polyelectrolytes fed as needed.			Expected effl. levels were: SS 30 F (Diss.) 25 Pb + Zn (tot. diss.) 1.0 CN (uncomplexed) 0.1 (max) As 3/79 these levels have not been achieved.
FRANCE								
Pont-a-Mousson	2/ 1 @ 600 1 @ 800	Disintegrator	8.1	River	Settling in pond. Daily settled blowdown treated with NaOH and H_2SO_5 (Caro's acid)	99-99.7	River	Solids to landfill from pond. During furnace shutdowns CN level in the cleaning water is increased between 2 and 200 mg/l from a normal level of 0.5 mg/l.
ITALY								
Taranto	5/ 26,000	washers	1 @ 9 2 @ 4.8 1 @ 12 1 @ 6	River	Settling	3 @ 91.9 1 @ 96 1 @ 94	To Gulf of Taranto with other plant wastes	Solids to Sinter
JAPAN								
Kawasaki Steel Chiba Works	5/ 1 @ 2500 2 @ 3500 1 @ 5200 1 @ 10000	Venturi	3.8	Lake & Blast Furnace cooling blowdown	Aeration (12 min), polyelectrolyte addition, thickener ($3\ m^3/m^2/hr$), cooling	97.5	Slag cooling	Solids dewatered in a tube press and sent to pelletizing plant.

TABLE 4-7. SUMMARY OF FOREIGN BLAST FURNACE PRODUCTION AND WASTEWATER TREATMENT METHODS (Sheet 3 of 5)

Country/ Plant	No. of Blast Furnaces/ Production (Mg/day)	Gas Cleaning System	Vol. of Water Applied (m^3/Mg)	Source of Makeup	Gas Washer Water Treatment	Percent Recycle	Blowdown to	Notes
JAPAN (Cont'd)								
Kobe Steel Kakogawa Works	3 (2 operate at one time)/ NA	Each blast furn: 1 venturi & 3 WESP	Volume for 2 furnaces: 2800 m^3/h	Furnace cooling blowdown	NaOH & polyelectrolyte added to thickener, cooling	98.5	Slag quench	Solids to pelletizing plant.
Nippon Kokan KK Ogishima Works	1/ 8000	Venturi, mist separator, WESP	Venturi: 3-4 WESP: 0.375-0.5	Blast furnace cooling blowdown	Flow control pond, thickener, 2nd flow control pond, cooling	88.9-94.4	Slag quench & dust suppression	Solids to sintering plant.
Sumitomo Metals Kashima Works	3 (2 operate at one time)/ 8000 each	1 BF uses ring split washer. 2 BF use venturi & WESP	3	River	Polyelectrolyte & clarifier	83	Slag quench	Solids to pelletizing plant.
MEXICO								
Altos Hornos	4/ 1 @ 1600 1 @ 1000	Washer, WESP	8.75	Wastewater lagoon	3-21.3 m diameter clarifiers, cooled	98	To lagoons as sludge	Lagoon is 2 lagoons in series with a total volume of 22,000 m^3. Other flows to lagoons are Blast Furnace cooling blowdown, demineralizer regenerants, treated municipal sewage. Discharge to river is from 0 to 108 m^3/hr. Recycle to plant is from 136 to 270 m^3/hr for coke and slag quench and for blast furnace and BOF gas cleaning.
	1 @ 1200 -	Orifice Plate						
	1 @ 1500 -	Venturi	7.2		1-16.8 m diameter clarifier, cooled	91.1		
NETHERLANDS								
Hoogovens	5/ 1 @ 7000 1 @ 3000 2 @ 2300 1 @ 1000	Bischoff scrubber, venturi	3.5	Harbor (salt water)	None	0	N/A	Solids to harbor. Future plans (1982) call for fresh waters aeration, with lime addition and settling. Recycle at 97.2%.
SOUTH AFRICA								
ISCOR-Pretoria Works	4/ 3 @ 750 1 @ 1800 (BF No. 4)	BF 1 & 2: Venturi & WESP BF 3: Disintegrator	7.5	River water	BF 1 & 2: $Ca(OH)_2$ addition, settling, cooling BF 3 & 4: Polyelectrolyte addition, settling, cooling	96.1	Slag quench and sludge	Solids to slag dump. Sludge pumped to railroad cars for thickening and hauling to slag dump. Water that leaches out of bottom of slag granulation pit has negligible COD, no H_2S odor, no CN, TDS 3000-5000 mg/l.
		BF 4: Spray Tower and WESP	12.1					

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TABLE 4-7. SUMMARY OF FOREIGN BLAST FURNACE PRODUCTION AND WASTEWATER TREATMENT METHODS (Sheet 4 of 5)

Country/ Plant	No. of Blast Furnaces/ Production (Mg/day)	Gas Cleaning System	Vol. of Water Applied (m3/Mg)	Source of Makeup	Gas Washer Water Treatment	Percent Recycle	Blowdown to	Notes
SOUTH AFRICA (Continued)								
Newcastle Works	1/ 2500	Bischoff Scrubber	14.4	River water	Grit removal in 2 clarifiers (15 m diameter). 2 clarifiers with polyelectrolyte addition (50 m dia.).	98.4	Slag quench	Part of solids to sinter plant, part dumped. Slag quench water is recycled. Scaling noticed in slag quench recycle line.
Vanderbijlpark	4/ 2 @ 1360 1 @ 2200 1 @ 3000	WESP	10.6	Settled river water	Polyelectrolyte, 4 thickeners (overflow rate 1.7 $m^3/m^2/hr$), cooling	96.3	Coke quench and irrigation for grass crops	Blast furnace recirculation system experiencing scaling on cold side and corrosion on hot side. Polyolester added to control scaling. No discharges to public water.
SWEDEN								
Svensk Stal Norbottens Jarnverk	2/ 1 @ 1500 1 @ 3000	No. 1 cyclone WESP (1) No. 2 Bischoff scrubber	No. 1: 9.6-14.4 No. 2: 4.8-7.2	Lulea R.	Each blast furnace: thickener with polyelectrolyte addition.	95-97.8	Sludge lagoon, overflow to 2nd lagoon & mixed with cooling water. Overflow to Lulea R.	Solids to Sludge lagoon.
Surhammars Bruks Spannarhyttan	1/ 1073	Scrubber, WESP	3.9 avg.	River	Scrubber water (150 m^3/hr) to thickener. WESP water (25 m^3/hr) to lagoon then to thickener.	98	Pig caster which overflows to a pond.	Solids vacuum filtered and stockpiled (2).
TAIWAN								
China Steel	1/ 4000	2 stage venturi	7.2	Water softening sludge, treated water, air cond. water	Polyelectrolyte & thickener	99	Industrial waste lagoon	Solids dewatered on vacuum filter and sold to cement company.
WEST GERMANY								
Roechling Burbach	6	Dry	0	-	-	-	-	Totally dry gas cleaning.
Thyssen	1/ 9000 to 10,000	Scrubber	6.9	City pot. water	Aeration (12 min), settling (overflow rate 3.82 $m^3/m^2/hr$), polyelectrolyte added	98.8	Slag quench	Solids dewatered in filter press and stored.

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TABLE 4-7. SUMMARY OF FOREIGN BLAST FURNACE PRODUCTION AND WASTEWATER TREATMENT METHODS (Sheet 5 of 5)

Country/ Plant	No. of Blast Furnaces/ Production (Mg/day)	Gas Cleaning System	Vol. of Water Applied (m^3/Mg)	Source of Makeup	Gas Washer Water Treatment	Percent Recycle	Blowdown to	Notes
WEST GERMANY (cont'd)								
Hoesch-Huttenwerke Phoenix	3/ 1 @ 4500 2 @ 3000	Lurgi quench & WESP	1 @ 6 1 @ 12 1 @ 11.2	City pot. water & plant seepage	3 clarifiers in a common system (overflow rate: 0.5 $m^3/m^2/hr$). Cooling towers with addition of poly-phosphate	99.2	2 sludge ponds. Underflow to Emscher River.	Solids to sludge ponds. NaOH is added to sludge to lagoon to raise pH. When furnaces shut down CN increases.
Westfallen	2/ 2 @ 4500	venturi & quench	6.4	City pot. water & plant seepage	2 clarifiers. Same as Phoenix.	99.1	2 sludge ponds. Underflow to Lipper River.	Solids to sludge ponds. Cold rolling mill sludge added to blast furnace sludge.

NOTES: NA - not available
(1) WESP is wet electrostatic precipitator
ESP is dry electrostatic precipitator
(2) Solids cannot be used because of high zinc and lead content.

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TABLE 4-8. U.S. VERSUS FOREIGN BLAST FURNACE WASTEWATER EFFLUENT QUALITY (Sheet 1 of 3)

		Water Applied	Water Recycled		Water Disch.		Treated Water to Discharge											
							Suspended Solids		CN		Phenol		NH_3-N		F		Sulfide	
No.	Plant	m^3/Mg	m^3/Mg	%	m^3/Mg	pH	mg/l	kg/Mg	mg/l	kg/Mg	mg/l	kg/Mg	mg/l	kg/Mg	mg/l	kg/Mg	mg/l	kg/Mg
	U.S.(1)				0.292	6-9	15	4.4×10^{-3}	1.0	2.92×10^{-4}	0.1	2.92×10^{-5}	1	2.92×10^{-5}				
	ARGENTINA -	8.1	0	0	8.1 (PS)					NO QUALITY DATA PROVIDED								
	AUSTRALIA																	
	Hoskins-Kembla	8.5	0	0	8.5	7	40	3.4×10^{-1}	x	x	x	x	x	x	x	x	x	x
		6	0	0	6	8.5	30	1.8×10^{-1}	0.15	9×10^{-4}	x	x	2.0	1.2×10^{-2}	x	x	x	x
		2.1	0	0	0(S)	8.2	21	(M)	0.5-	(M)			5	(M)				
	BHP Newcastle	6.4 (A)	5.73	89.5	0.67 (SL)	8.3	x	x	0.3	2×10^{-4}	x	x	100	6.7×10^{-2}	x	x	x	x
	BELGIUM Sidmar	7.25 (A)	2.63	29.6 (A)	4.61	6.6		NO OTHER QUALITY DATA PROVIDED										
	ENGLAND																	
	Scuntnorpe: Apex	12.6	12.4	98.6	0.2 (SL)	8.3	50	1×10^{-2}	10	2×10^{-3}	x	x	x	x	60	1.2×10^{-2}	x	x
	Seraphim	13.3	13.06	98.2	0.24	8.3	55	1.3×10^{-2}	10	2.4×10^{-3}	x	x	x	x	70	1.7×10^{-2}	x	x
	Redbourn	28	27.5	98.4	0.5	8.2	50	2.5×10^{-2}	10	5×10^{-3}	x	x	x	x	70	3.5×10^{-2}	x	x
	Normanby	14	13.3	95	0.7	7.6	100	7×10^{-2}	5	3.5×10^{-3}	x	x	x	x	20	1.4×10^{-2}	x	x
	FRANCE Pont-a-Mousson	8.1	8.03- 8.07	99- 99.7	0.03- 0.07	8.6	0	0	0.1	7×10^{-6}	0.5	3.5×10^{-5}	x	x	x	x	x	x
	ITALY Taranto	7.3 (A)	7.0	96.1 (A)	0.28	x	30	8.4×10^{-3}	2-3	5.6×10^{-4} -8.4×10^{-4}	Neg.	-	x	x	x	x	x	x

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TABLE 4-8. U.S. VERSUS FOREIGN BLAST FURNACE WASTEWATER EFFLUENT QUALITY
(Sheet 2 of 3)

No. Plant	Water Applied	Water Recycled		Water Disch.		Treated Water to Discharge: Suspended Solids		CN		Phenol		NH_3		F		Sulfide	
	m^3/ Mg	m^3/ Mg	%	m^3/ Mg	pH	mg/l	kg/Mg	mg/l	kg/Mg	mg/l	kg/Mg	mg/l	kg/Mg	mg/l	kg/Mg	mg/l	kg/Mg
JAPAN																	
Sumitomo Metals Kashima Works	3	2.5	83	0.5					NO QUALITY DATA PROVIDED								
Nippon Kokan KK Ogishima Works	3.9	3.5-3.7	88.9-94.4	0.2-0.4					NO QUALITY DATA PROVIDED								
Kawasaki Steel Chiba Works	3.8	3.7	97.5	0.1 (S)	8.1	9	$9x10^{-4}$	x	x	x	x	x	x	x	x	x	x
MEXICO																	
Altos Hornos	8.26	6.56(2)	79.4	0.64 (SL)					NO QUALITY DATA PROVIDED								
NETHERLANDS																	
Hoogovens	3.5 (A)	0	0	3.5					NO QUALITY DATA PROVIDED								
S. AFRICA																	
ISCOR-Pretoria Works	9.5 (A)	9.13	96.1	0.37 (S)	8.3	46	$1.7x10^{-2}$	15 (CNS)	$5.5x10^{-3}$	x	x	101	$3.7x10^{-2}$	x	x	x	x
Newcastle Works	14.4	14.2	98.4	0.2 (S)	7.7	50	$1x10^{-2}$	11	$2.2x10^{-3}$	x	x	x	x	x	x	x	x
Vanderbijlpark	10.6	10.2	96.3	0.4	x	x	x	2	$8x10^{-4}$	x	x	100	$4x10^{-2}$	8	$3.2x10^{-3}$	x	x
SWEDEN																	
Svensk Stal	4.8-14.4	9.1-28.2	95-97.8	0.5-1.4					NO QUALITY DATA PROVIDED								
TAIWAN																	
China Steel	7.2	7.13	99	0.07 (SL)	7.5	20	$1.4x10^{-3}$	0.2	$1.4x10^{-5}$	x	x	x	x	x	x	x	x
WEST GERMANY																	
Hoesch Huttewerke Phoenix	9.2 (A)	9.13	99.2 (A)	0.07	9	50	$3.5x10^{-3}$	0.1	$7x10^{-6}$	x	x	x	x	x	x	x	x
Hoesch Huttewerke Westfallen	6.4	6.34	99.1	0.06					NO QUALITY DATA PROVIDED								
Thyssen	6.9	6.82	98.8	0(S)					NO QUALITY DATA PROVIDED								

TABLE 4-8. U.S. VERSUS FOREIGN BLAST FURNACE WASTEWATER EFFLUENT QUALITY (Sheet 3 of 3)

NOTES:

(1)	U.S. quality is that in Proposed Effluent Limitations Guidelines (BAT Alternate 4) and is shown for comparison purposes.
(2)	Data is for Blast Furnace No. 4 only. Data for other blast furnaces not calculated due to intermingling at wastewater with other systems.
(A)	Average value
(S)	Slag quench
(SL)	Blowdown as sludge (Quality is recycle water quality)
(PS)	Part slag quench, part discharge
(M)	Slag quench overflow mixed with other wastes
x	No data
Neg	Negligible

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treats its by-produce coke plant wastewater in a biological treatment plant. Sizes of facilities, flows and influent and effluent wastewater qualities were not available. Since more detailed data were not available further discussion of these plants is not warranted. The third plant is discussed at the end of this section.

Table 4-4 shows the foreign by-product coke plant production data and wastewater treatment processes used. Where ammonia stills are used, they are considered to be a wastewater treatment facility even though, in most cases, they are used as a source of ammonia for the production of ammonium sulfate. In some cases the ammonia is incinerated. Table 4-5 lists the wastewater quality before treatment and Table 4-6 lists the wastewater quality after treatment. All quality data provided is shown even if the treated wastes are totally evaporated during quenching operations and not discharged.

Table 4-7 shows the foreign plant blast furnace production data, the waste treatment processes used and the extent of water recirculation at each of the plants. Table 4-8 lists the quality of water discharged from the treatment systems. This water quality data is shown even if the water is not discharged but evaporated at quenching operations.

Tables 4-5, 4-6 and 4-8 list the parameters monitored by the foreign plants, these do not include all contaminants listed in the U.S. EPA Effluent Limitations Guidelines as their determination is not required by foreign regulatory agencies.

While visiting the Australian Iron and Steel, Hoskins-Kembla Works in Port Kembla, N.S.W., there was an opportunity to visit the John Lysaght (Aust.) Ltd. organization to discuss the hot and cold mill water systems at its Westernport Bay facility. The hot strip mill operates with the lowest blowdown of any such facility in the world and features four recirculating water systems.(3) One is a completely closed non-contact cooling water system for reheat furnace skid cooling. The other three systems cascade the water. Makeup water consists of a mixture of a purchased supply and collected storm water. The makeup is applied to the area where highest quality water is required. Blowdown is cascaded from high quality systems to those which require lower quality. The contact cooling water is filtered, cooled and recirculated. Blowdown from the system discharges to Westernport Bay via the plant's cold mill effluent lagoon. The plant reports that the total discharge from the mill is 0.2 m^3/Mg (48 gal/ton) with mass discharges of 0.002 kg/Mg (lb/1000 lb) each of suspended solids and oil. The cold mill complex, consisting of a

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hydrochloric acid pickler, a 5-stand cold reduction mill, a galvanizing line, a coating line and a paint line, also is an excellent example of conservation, reuse and pollution control.

4.3 FOREIGN REGULATIONS

Regulatory agencies of nine foreign governments provided information on the regulatory climate and the relationship that these agencies have with industry. This gave a better understanding of the individual plant pollution control practices. Countries that are members of the European Economic Community (EEC) have been issued a policy directive with regard to control of water pollution in the community; to date, however, the regulations of the individual countries have taken precedence.

In addition to the regulatory agencies, discussions were held with VDEh, a West German trade association which represents the iron and steel industry. Representatives of several steel companies and the West German Federal Government attended the meeting.

Only two of the ten countries from which regulations were obtained have, or will have, regulations specific to the iron and steel industry. All others have regulations which pertain to the quality of effluent or to the effect on the receiving body. The regulations are determined by the use of the receiving body: i.e., potable water, fishing, recreation, etc.

In the discussions all countries states that input from special interest groups outside of government and industry has little effect in the establishment of regulations. Generally, the bases for regulations are: preservation of public health, minimizing environmental effects, aesthetic considerations and water conservation while considering the economic impact of the regulations on the individual plant, the industry and the country.

All agencies reported that the industries or individual companies to be affected by proposed regulations are consulted prior to the promulgation of the regulations to determine, jointly, if changes based on available technology or economic conditions are necessary.

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4.3.1 European Economic Community (EEC)

The EEC has defined, in its "Council Directive of 4 May 1976 on Pollution Caused by Certain Dangerous Subtances Discharged into the Aquatic Environment of the Community",(4) two classes of substances to be controlled. Each has different criteria. These classes are presented in two lists:

List I specifies "certain individual substances selected mainly on the basis of their toxicity, persistence, and bioaccumulation, with the exception of those which are biologically harmless or which are rapidly converted into substances which are biologically harmless".

Examples of substances contained in List 1 are:

organohalogens, organophosphorous, and organotin compounds

carcinogens

mercury and cadmium and their compounds

persistent mineral oils and hydrocarbons of petroleum origin

List II contains "substances which have a deleterious effect on the aquatic environment, which can, however, be confined to a given area and which depend on the characteristics and location of the water into which they are discharged...".

Examples of substances contained in List II are:

heavy metals and their compounds

biocides and their derivatives

taste and odor producing compounds

phosphorous and its inorganic compounds

oxygen demanding substances

The objectives of this directive are to eliminate or limit discharges of the substances in List I by establishing effluent limitations. The effects of the discharges in List II are controlled to maintain or improve ambient water quality by establishing water quality standards. In its directive the EEC also stated that discharges to the open sea by means of pipelines must meet criteria that are no less stringent than discharges to inland surface waters.

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4.3.2 Argentina

General regulations that limit discharges are in effect throughout Argentina. A general law establishes a system of fees based on flow, days of operation, economic index and specific parameters that exceed limitations.(5) However, a new law is in effect that regulates industrial wastewater discharges in the Greater Buenos Aires area. This law will apply to the entire nation eventually.

An additional schedule of fines is being established for industries. It will be based on the equivalent annual costs, amortized over 20 years, of a treatment plant that would produce a satisfactory effluent.

Steel plants will have regulations promulgated to limit specifically cyanide, BOD_5, ammonia, phenol, chloride and fluoride, in addition to the generally controlled parameters, namely pH, ether solubles, settleable solids, chemical oxygen demand, chlorine demand, detergents, chromium (trivalent and hexavalent),arsenic, chlorine, lead, mercury (total) and sulfate. Other industries will have similar limitations.

4.3.3 Australia

In Australia, the New South Wales State Pollution Control Commission (PCC) is the sole authority for pollution control within the state. There are no industry-wide guidelines for specific industries. A permit (license) system has been established for the discharge of any industrial wastewater. Each permit is handled on a case by case basis and the license is renewable annually. The license specifies discharge qualities that are to be reached by a specific date.

PCC target values are based on what it perceives to be achievable limits and the plant submits the technology to be used. The PCC evaluates the plant presentation and the two parties, the plant and the PCC, negotiate the final effluent limits. The PCC operates with discretionary powers within a law that is extremely flexible. Thus far, the response from industry has been favorable.

The PCC is prohibited from revealing any information about the industry, even to local governments. Each plant is required to be self-monitoring. The PCC takes periodic samples. If there are accidental spills, or other non-compliant discharges, prosecution is possible; depending on the circumstances of the non-compliant act, prosecution may or may not be instituted.

4.3.4 England

In 1973, England established ten Water Authorities which were based on catchment areas or river basins. These Authorities have complete control of the human aspects of the water cycle within their area. They are also responsible for the operation of sewage treatment plants. Many industries discharge to the sewage treatment plants and the Authorities may require pretreatment prior to discharge.

All rivers in England are categorized into one of four classes:

Class I. High quality rivers that support salmonoid fish and, with only minor treatment, can provide potable water.

Class 2. Rivers that support coarse fish and, with treatment more advanced than for Class 1 rivers, can provide potable water.

Class 3. Rivers that support some game fish and whose waters are used for irrigation. This water, even with treatment, is not considered suitable as a source of potable water.

Class 4. Visually poor and unsuitable for fish, irrigation or a potable supply.

The national policy is that all rivers must be classified as either Class 1 or 2 and that all are also subject to specific water quality criteria (DO, BOD_5, NH_4^+, etc.).

The individual Water Authorities consist of a chairman appointed by the Secretary of State and other members appointed by local officials. Industry is also represented by membership. These Water Authorities negotiate with the dischargers to develop effluent criteria, considering the present and future uses of the receiving body and the material being discharged. The mutually-agreed-upon discharge qualities are termed the "consent" conditions by which the discharger must abide. As a guide, the discharge limits are expected to be linked to the EEC recommendations. In establishing consent conditions, the total individual industrial plant discharges are considered on a case by case basis. The consent conditions are reviewed by the Water Authority no less than two years after a permit is issued.

Wastewater treatment research receives public funding through the National Water Research Centre. Industry also funds its own research. Before application of a new technology at an industrial facility, a cost test is applied. Details of the cost test were not supplied. The review of technology is conducted by the directors of scientific services from the National Centre, industry, and the Water Authorities.

Although the individual Water Authorities are responsible for and establish the discharge consent conditions, the National Department of the Environment provides guidance to the local Authorities. The philosophy of the Department of the Environment is that the contaminant being discharged, rather than the individual industry should be limited. For example, a coke plant and plating plant may both discharge cyanides. It would be suggested that both should be subjected to the same effluent limitations and the fact that the in-plant sources are different would not affect the degree of treatment required. The Department of the Environment is reluctant to suggest absolute standards because of the receiving water quality approach taken by the Water Authorities.

4.3.5 Japan

In addition to control by the prefectures (the equivalent of States in the United States), there are two national agencies involved with pollution control in Japan.

The Environment Agency (EA) has established two types of nationwide standards: environmental water quality standards which pertain to ambient water (i.e. rivers, lakes and coastal waters) and effluent standards. Each of these standards are further subdivided into two subtypes: those relating to the protection of human health and those relating to the living environment (the best use for the water). These standards serve as a guide to the prefectures.(6,7,8,9)

The EA has established a central advisory council of over 100 people including representatives of industry. The council makes recommendations from which the standards are established. A large industry will usually have stricter standards than a small industry. Presently a bubble concept is being promulgated. Each plant effluent must meet regulations and the total mass load from the plant will also be limited.

The second national agency involved in pollution control and environmental matters is the Ministry of International Trade and Industry (MITI). MITI has two environmental protection divisions - a policy division and a guidance division. The latter enforces the regulations.

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The EA submits its plans for regulation to all of the government ministries. MITI goes to the various plants for discussions. If a plant can demonstrate that a plan is too expensive to implement, the EA regulations established on the basis of health are set as a minimum standard and the regulations established with respect to environmental considerations are adjudicated on a case by case basis. With the advice of MITI, the prefecture establishes the final environmental standards which may be stricter than the EA standards but not more lenient. New plants will have stricter standards than existing plants.

The problem presently being addressed by both government agencies is eutrophication. Nitrogen, COD, and phosphorus are discharged and a "red tide" appears periodically in the Inland Sea. Standards for COD have been established and standards for phosphorus and nitrogen are being developed.

Environmental research and development at universities and industrial laboratories may be partially funded by MITI and other governmental agencies. EA coordinates all governmental funded R & D studies on environmental issues.

4.3.6 Mexico

There are two principal Federal Agencies concerned with water quality and wastewater control in Mexico: the Secretary of Public Health and Assistance(SSA) and the Secretary of Hydraulic Resources (SRH).

Regulations were established in March 1973. All industries were given 6 months to improve the quality of their effluents or pay a tax to the Government when untreated or partially treated effluents were discharged to a municipal sewerage system. This tax is compensation for the additional cost to the city to treat the industrial wastes.

The limits for wastewater discharges are:

pH	4.5 - 10
Settleable Solids	10 ml/l
Oil and Grease	70 mg/l
Temperature	35° C.
Floating Material	None that can be retained by a screen with openings 3 mm or larger.

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The receiving bodies have been categorized into five classes with each class suitable for specific uses. The classifications are DA, DI, DII, DIII and DIV. The highest classification, Class DA, is suitable for potable water requiring only disinfection, and the lowest quality, Class DIV, is suitable for industrial process water other than food processing.

The basic parameters for classifying the waters are pH, temperature, dissolved oxygen, coliforms, oil and grease, dissolved solids, turbidity, color, odor, nutrients (nitrogen and phosphorous), floating material and 28 toxic substances. Discharges are not permitted which would cause the receiving body to be degraded to a lower classification.

The law also mandates that all stream classifications be reviewed every five years.

4.3.7 Netherlands

6-1/2

The Netherlands has two agencies concerned with water quality and wastewater control: the Ministry of Public Health and Environmental Protection and the Ministry of Traffic and Water Management (RIZA). For the past 20 years the major emphasis has been on air pollution; water standards are presently being established. The basis for the new water standards will be both technological and economic. RIZA is the environmental advisor for state water (large bodies of water). When standards are set RIZA will operate in concert with the Ministry of Economic Affairs. At the present time, standards have not been established for the steel industry. They will be enforced on a case by case basis with economics as a major consideration.

After a standard has been established, industry will be given one year to prepare a pollution abatement plan for discussion. After the Ministry and the industry have reached an agreement, a date will be set for construction of the treatment facilities. Discharge from the completed facility will be analyzed and, if better than anticipated, these figures will be used in the discharge permit. The permit will also state the volume of wastewater to be discharged. If the results of the treatment are not as good as anticipated, the industrial plant, after further discussions with the Ministry, may be required to upgrade the treatment facilities.

RIZA is presently obtaining data on the actual discharges of pollutants from industry to determine effective treatment processes. The treatment to be used is the "best practical means".

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Industrial plants will not be given a license to discharge unlimited quantities and concentrations of pollutants to the sea. The EEC has also stated that discharges to the open sea, by means of pipelines, must meet criteria that are no less stringent than those of discharges to inland surface waters. Charges are levied against dischargers. The charge is based on oxygen consuming substances and certain heavy metals. It is considered unlikely that the Netherlands, or any other member country of the EEC, will establish stricter standards than those published by the EEC so as not to be placed in a relatively uneconomic position.

4.3.8 South Africa

The Republic of South Africa, through the Minister of Water Affairs, controls both the quantity of water that an industry may use and the quality of water than an industry may discharge. South Africa is extremely arid. Unless strict controls are enforced, the country will use all available water at least once by the early part of the 21st century.

The Government has established three types of effluent standards, i.e., general standards for the entire country, regional standards and standards for specific industries. Exemptions may be granted if industry convinces the Minister that a hardship would be created if the general standard must be met. However, an exemption must not lead to conditions that would be deleterious to the receiving water. A request for an exemption must be directed first to the National Bureau of Standards and then to the Minister.(13, 14, 15, 16)

Industrial associations work with the Government to establish standards or guidelines. The Government then publishes them for comment. Normally there are very few comments and the guidelines are accepted as published.

Since the quantity of water that may be used is severely limited, recirculation and reuse is strongly encouraged as are manufacturing processes that require minimal use of water. Application must be made to the Minister for permission to withdraw any water from a stream or well. The application must detail the sources of water, the uses of the water in the manufacturing process and the details of the plant effluents. Additional information required includes details of the water treatment plant and the expected operation of the wastewater treatment plant during heavy storms and during the rainy season.

Although not specifically stated in the law, an implication can be drawn from the application requirements that a more favorable review will be given to systems that propose the reuse and recirculation of water.

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4.3.9 Sweden

Although national regulations for the discharge of pollutants have not been established in Sweden, the goal is the zero discharge of pollutants. Presently, each industrial discharge is considered technically, economically and environmentally on an individual basis.

The National Swedish Environmental Protection Board (NSEPB) is using proposed U.S. standards as a reference and minimum discharge standards will probably be similar to the standards promulgated as BPT by the U.S. EPA. The required recycle rate for the plants will be approximately 90 to 95 percent. The NSEPB expects that industry will cooperate to reach maximum recycling.

The following excerpt from "Environmental Protection, a Growing Public Task", a publication of the Swedish Ministry of Agriculture and the NSEPB illustrates the approach taken by the Swedish Government to reduce water pollution.(17)

> "The worst water pollution is due to industry. The situation has improved since the mid-1960s, however. Industries are pouring less waste into natural waters, although industrial production has risen sharply. Take the pulp and paper mills, for example. They discharge a great deal of lignin and other substances that use up the oxygen in lakes, rivers, etc. The annual discharge of these substances has dropped. In 1972, it was 250,000 (metric) tons less than in 1965, a reduction of 30 percent. Yet output of pulp and paper rose by about the same percentage. Or take the iron and steel mills. Each year, they now emit 1,000 tons less oil into the water, and 8,000 tons less metal.
>
> The reduction of water pollution has two main causes. One is severe environmental legislation. The other is the State grants which have been available since 1969.
>
> These grants are mainly intended for improving old industries. They cover 25 percent of the building costs. However, these grants have also been used for stimulating employment. For this purpose, they were raised to cover 50-75 percent of the building costs at times furing the years 1971-74.

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During the last five years, industries were granted a total of 720 million kronor* for improving the environment. Almost two thirds was used for reducing water pollution.

In addition to the above practical reforms, continuous research is going on. One aim is to find better ways of purifying waste. Another is to work out means of production that do not harm the environment. A third aim is to find out how to recycle waste products instead of discharging them into nature together with wastewater. These approaches have enabled iron and steel mills to save more than 30 million cubic meters of water a year."

Although most of the research work is performed on the treatment and reduction of wastes in the pulp and paper industry, the NSEPB personnel stated that systems for the regeneration of nitric and hydrofluoric acids, which are used in specialty steel pickling, have been developed, they will have a three-year payback period. Details of the processes were not revealed(21).

4.3.10 Taiwan

The Government of Taiwan passed a pollution control law on July 2, 1974, which became effective in 1976. Special agencies have been assigned to establish pollution control regulations and handle research matters. The enforcement of such regulations is the responsibility of local government.

The law(18) requires discharge permits for all private and government-owned industrial, agricultural or municipal facilities. Effluent quality standards depend on the classification of the receiving streams, lakes or coastal waters. There are five classes for rivers and lakes, depending on the use of the water. The range of effluent criteria are:

pH	6.0 - 9.0
BOD	1-100 mg/l
Suspended Solids	25-100 mg/l
Dissolved Oxygen	26.5 mg/l
Coliform Bacteria	50-10,000 MPN/100 ml
Heavy metals	0.005-0.10 mg/l

Coastal waters are classified into three categories: bathing and fishing, industrial, or aesthetic. The range of effluent quality are (depending upon classification):

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* approximately 180 million U.S. dollars.

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pH	7.0-8.5
COD	2-8 mg/l
Dissolved Oxygen	2-6 mg/l
Coliform Bacteria	1000 MPN/100 l

Each permit holder must monitor his discharges and submit periodic reports to the authorities. The local regulatory agencies have monitoring stations to check on water quality.

Violators are notified initially to take corrective measures. A fine may be imposed and plants may be closed for serious violations. The fines presently range from 1000 NT ($28) to 5,000 NT ($140) per violation.

4.3.11 West Germany

The Government of the Federal Republic of Germany (West Germany) has established from 50 to 60 working groups composed of State, local and industrial interests to prepare discharge criteria. Their recommendations are scheduled to be made by 1980. If a decision with respect to guidelines cannot be reached, and it is determined that further research is necessary, then the national government may fund the research. Industry may also fund its own research. To meet the guidelines, a plant may select technology it deems most applicable. The iron and steel industry does not consider technology to be transferable from industry to industry, unless proven.

The guidelines will probably be similar to those of the U.S. EPA BAT. Guidelines established by the European Economic Community are believed to be too stringent. It was stated that the West German Government has had a high degree of cooperation from its steel industry.

The existing law establishes a system of fees for the discharge of wastes based on the volume and mass of contaminants discharged. A cost factor "S" will probably be set based on the loads of COD, mercury and cadmium and volume of settleable solids in the effluent. The yearly fee paid to the Government will be multiples of the factor "S" ["S" times 12 DM (US $6.56)] by January 1, 1981. It will escalate annually to "S" times 40 DM (US $21.86) by January 1, 1986. Different Standards may differ for streams depending upon stream use. Enforcement will be on a case by case basis.

The wastes from approximately 40 percent of the entire West German iron and steel industry are discharged, along with wastes from other industries, to the Emscher River. The river is completely diverted near its mouth to a biological waste treatment plant and, after treatment, empties into the Ruhr river.

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TABLE 5-1

COKE PLANT WASTEWATER TREATMENT TECHNOLOGY USED IN THE UNITED STATES*

	Percentage of Production Tonnage Utilizing Technology Shown
Free Ammonia Still	65.5
Fixed Ammonia Still	64.2
Dephenolizer	42.8
Alkaline Chlorination	1.1
Carbon Adsorption	2.7
In-plant Biological Oxidation	37.5
Ozone	0.7
Oxidation Tower	0.8
No Treatment	3.4

* Data from: Development Document for Proposed Effluent Limitations Guidelines and Standards for the Iron and Steel Manufacturing Point Source Category. Vol. II. EPA 440/1-80/024-b. December 1980, pp. 19-21.

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In 18 (37.5 percent) of the coke plants, biological treatment is used. Three of these 18 plants discharge all or most of their biologically treated wastes to a POTW for further treatment.

Five plants, in addition to the two using deep wells, report that there is no on-site treatment. Three of these plants discharge all or the major portion of their wastes, to a POTW. One plant discharges a portion of the untreated wastes to receiving waters. All of the untreated wastes not directly discharged, discharged to POTW"s or pumped into deep wells, is used for quenching coke.

Table 5-2 lists six plants which have various coke plants wastewater treatment facilities and, for which, some detailed data is available in the Development Document. This table includes data on flow rates and raw and treated wastewater contaminant levels. Table 5-3 is a comparison of the quality of coke plant wastewater to treated effluent.

5.2 BLAST FURNACE WASTEWATER TREATMENT

Blast furnace wastewater treatment techniques in the U.S. are summarized in Table 5-4. From 12.2 to 13.4 percent of the wastewater is not treated. All of the treatment systems employ solids removal by either classifying,plain settling (either aided or unaided by flocculant aids) or screening. Some 42 percent of the process water used at blast furnaces is recycled or reused. Of the 53 operating plants for which data is available, 20 plants recycle or reuse from 27 to 100 percent of the water after treatment. Twelve plants segregate wastes so that a portion is treated and recycled and the balance discharged either with or without treatment. Twenty one plants do not recycle.

Unit operations shown on Table 5-4 are only for waste waters from blast furnaces. Some steel mills have central treatment plants that combine wastewaters from several steel making processes. These are not considered here as it is impossible to isolate the blast furnace wastewaters.

A distinction is not made between clarifiers and thickeners unless they are used separately at one treatment facility. The terms clarifier and thickener are generally used interchangeably at steel plants. In sanitary engineering parlance, the term "thickener" is used to describe a unit that receives the underflow from a "clarifier" to further increase the suspended solids, or sludge, concentration. In four installations at three plants both clarifiers and thickeners are being used and at five plants, settling lagoons follow clarifiers or thickeners. Because of this the percentages in Table 5-4 are not additive.

TABLE 5-2. SUMMARY OF U.S. BY-PRODUCT COKE PLANT PRODUCTION AND WASTEWATER TREATMENT DATA AT SIX PLANTS

Plant (U.S. EPA Development Document Code)	Production kkg/day	Source	Application Rate Loss Rate (m^3/Mg)	Volume of WAL Produced (m^3/Mg)	Total Waste Flow & Sources (m^3/hr)	Treatment	Notes
464 C	545	Quench car scrubber blowdown	NA(1) NA	0.11	Gas main drips, primary cooler, tar precipitator, final cooler blowdown: 3.41	Tar decanter, dephenolizer, alkaline chlorination	Discharge to POTW.
684	3889	Treated benzol plant wastes	NA 0.21	0.2	WAL & Benzol plant wastes: 66.4	For quench: gas flotation, filter, activated carbon. For discharge: gas flotation (side stream through dephenolizer, filtration, activated carbon), FAS. FXAS (2)	
732 A	1482	Fresh water and final cooler blowdown	1.8 0.82	0.24	WAL: 14.82, Decanter and exhauster: 18.5, cooling water: 1642	WAL only: FAS, dephenolizer	
868 A	3574	Coal preheater, cooling tower blowdown	NA 0.84	0.11	WAL: 17.3, Misc. wastes: 42.9	Gravity oil separator, FAS, FXAS, clarifier, equalization (30 hr), aeration (2 days), clarifier.	Discharge from clarifier discharged to settling with other plant wastes. Dilution water added at a ratio of 13:12 water to waste.
920 F	3742	NA	NA NA	0.154	WAL: 24, Misc. wastes: 41	FAS, FXAS, combined with benzol wastes, equalization, cooled aeration.	
Clairton	18500 Avg.	NA	NA NA	NA	Primary & secondary coolers, phosam, light oil refinery, tar distillation: 395	Tar & oil separation, FAS, FXAS, clarifier, cooling, equalization, aeration, clarifier, filtration	Dilution water from river added at a ratio of 0.7:1 water to waste.

(1) NA - Not Available

(2) FAS is Free Still; FXAS is Fixed Ammonia Still.

Data for all plants other than Clairton from "Development Document for Proposed Effluent Limitations Guidelines and Standards for the Iron and Steel Manufacturing Point Source Category". Volume II, Table VII-3 and Figures VII-5 thru 9, inclusive. Data for Clairton from "Characterization and Evaluation of Wastewater Sources. USS Clairton Works, Pittsburgh, PA," EPA 330/2-75-025.

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TABLE 5-3. U.S. BY-PRODUCT COKE PLANT WASTEWATER TREATMENT PERFORMANCE AT SIX PLANTS

A. RAW WASTEWATER

Plant	Raw Flow Treat^d	Dilution Ratio Dil.:		Suspended Solids		CN		CNS		Oil & Grease		Phenol		Phenolic		Ammonia-N		Sulfide	
	m3/Mg	Waste	pH	mg/l	kg/Mg	mg/l	kg/Mg	mg/l	kg/Mg	mg/l	kg/Mg	mg/l	kg/Mg	mg/l	kg/Mg	mg/l	kg/Mg	mg/l	kg/Mg
464C(2)(3)	0.15	-	9.0	14	2.1×10^{-3}	21.5	3.23×10^{-3}	1247	1.87×10^{-1}	82	1.87×10^{-2}	x	x	702	1.05×10^{-1}	5067	7.6×10^{-1}	1833	2.75×10^{-1}
684F(5)	0.41	-	8.6	97	1.94×10^{-2}	25.9	5.18×10^{-3}	680	1.36×10^{-1}	83	1.66×10^{-2}	x	x	1715	3.43×10^{-1}	8255	1.65	976	1.95×10^{-1}
Clairton(4)	0.51	0.7 :1	8.2 -9	15	7.65×10^{-3}	490(6)	2.5×10^{-1}	525(7)	2.68×10^{-1}	x	x	616	3.14×10^{-1}	x	x	1900	9.69×10^{-1}	x	x
868A(4)	0.11-0.404	65 :60	9.7	80	8.8×10^{-3}	22.3	2.45×10^{-3}	59.3	6.52×10^{-3}	184	2.02×10^{-2}	x	x	628	6.9×10^{-2}	2391	2.63×10^{-1}	440	4.84×10^{-2}
920F(4)	0.154	-	8.8	44	6.73×10^{-3}	28.6	4.40×10^{-3}	659	1.01×10^{-1}	172	2.65×10^{-2}	x	x	1172	1.80×10^{-1}	4375	6.74×10^{-1}	908	1.4×10^{-1}
732A(1)	0.24	-	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

B. TREATED WATER TO DISCHARGE

Plant	Flow Discharged		Suspended Solids		CN		CNS		Oil & Grease		Phenol		Phenolic		Ammonia-N		Sulfide	
	m3/Mg	pH	mg/l	kg/Mg	mg/l	kg/Mg	mg/l	kg/Mg	mg/l	kg/Mg	mg/l	kg/Mg	mg/l	kg/Mg	mg/l	kg/Mg	mg/l	kg/Mg
464C(2)(3)	0.15	9.0	9	1.35×10^{-3}	16.2	2.43×10^{-3}	1050	1.58×10^{-1}	40	6×10^{-3}	x	x	84	1.26×10^{-2}	4885	7.33×10^{-1}	1773	2.66×10^{-1}
684F(5)	0.41	9	31	1.27×10^{-2}	22	9.02×10^{-3}	408	1.67×10^{-1}	9	3.69×10^{-3}	x	x	1	4.1×10^{-4}	218	8.94×10^{-2}	549	2.25×10^{-1}
Clairton(4)	0.87	6.5 -8.9	94	8.18×10^{-2}	2(6)	1.74×10^{-3}	9(7)	7.83×10^{-3}	x	x	0.076	6.61×10^{-5}	x	x	13.8	1.20×10^{-2}	x	x
868A(4)	0.84	7.4	39	3.28×10^{-2}	2.3	1.93×10^{-3}	2	1.68×10^{-3}	4	3.36×10^{-3}	0	0	x	x	1	8.4×10^{-4}	0.8	6.72×10^{-4}
920F(4)	0.596	7.6	43	2.56×10^{-2}	2.5	1.49×10^{-3}	1	5.96×10^{-4}	8	4.77×10^{-3}	ND	-	x	x	127	7.57×10^{-2}	ND	-
732A(1)	27.14	7.5	179	4.85	1	2.71×10^{-2}	26	7.06×10^{-1}	27	7.33×10^{-1}	x	x	8	2.17×10^{-1}	122	3.31	4	1.08×10^{-1}

(1) Dephenolizer
(2) Dephenolizer + Alkaline Chlorination
(3) Discharge to POTW
(4) Biological Treatment
(5) Raw waste for WAL only, treated wastes are total combined 0.2 m^3/Mg.

(6) Cyanide amenable to chlorination
(7) Total cyanide
ND = Non-detectable
x = No data

Data for all plants other than Clairton from "Development Document for Proposed Effluent Limitations Guidelines and Standards for the Iron and Steel Manufacturing Point Source Category." Volume II. Table VII-3, and Figures VII-5 thru 9, inclusive. Data for Clairton from "Characterization and Evaluation of Wastewater Sources. USS Clairton Works, Pittsburgh, PA." LPA 330/2-75-025.

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TABLE 5-4

BLAST FURNACE WASTEWATER TREATMENT TECHNOLOGY USED IN THE UNITED STATES*

	Percentage of Production Tonnage Utilizing Technology Shown
Large particle removal**	6.5-7.1
Flocculation with Ferric Chloride	2.8
Flocculation with Calcium Hydroxide	4.3
Flocculation with Polymer	25.3-29.9
Clarifier	19.3-23.9
Thickener	53.7-65.1
Settling Lagoon	12.6-16.0
Neutralization with Acid	16.3
Screening	9
Alkaline Chlorination	2.2
Break Point Chlorination	6.7
Cooling Tower	28.3
Treatment in Central Treatment Facility after Treatment at Blast Furnaces	3.4
Treatment in Central Treatment Facility only	14.4-14.8
No Treatment	12.2-13.4

* Data from: Development Document for Proposed Effluent Limitations Guidelines and Standards for the Iron and Steel Manufacturing Point Source Category. Vol. II. EPA 440/1-80/024-b. December 1980 pp. 310-316.

** Referred to in the Development Document as "Primary Scale Pit," but is probably a classifier which removes large pieces of coke, etc., from the wastewater.

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Of the treated blast furnace wastewater, 97.5 percent is discharged directly. Two percent is discharged to a POTW and 4.3 percent is used for quenching slag and other evaporative purposes.

Tables 5-5 and 5-6 show the production and wastewater treatment technology utilized at U.S. blast furnaces and the quality of the wastewaters discharged after treatment. In one case, there is insufficient data available on the quality of the treated effluent. These plants are those for which the Development Document contained some detailed information.(1)

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TABLE 5-5. SUMMARY OF U.S. BLAST FURNACE WASTEWATER TREATMENT TECHNOLOGY

Plant	No. of Blast Furnaces	Production Mg/day	Gas Cleaning System	Vol. of Water Applied m^3/Mg	Source of Makeup	Gas Washer Water Treatment	Percent Recycle	Blowdown To:	Solids To:
0396A	2	3175	Washers	8.59	Service	Thickener (overflow rate 1.84 $m^3/m^2/hr$), cooling	92	Sludge 45.4 m^3/hr; Sanitary authority. 22.7 m^3/hr	Sinter Plant.
0448A	4	1950	Washer, spray tower	13.98	Stack plate cooling system	Thickener, cooling	97	Slag quench, coke quench, BOF hood sprays	Dried in lagoon and dumped on slag pile
0060F	1	1505	2 venturis, gas cooler, dry ESP	13.03	NA	Polyelectrolyte, thickener, cooling	91.7	Slag quench, coke quench, BOF hood sprays	Vacuum filtered solids to sinter plant
0112D	4	9425	2 venturis, gas cooler	7.13	Slag pits	Polyelectrolyte, thickener, acid neutralization		Central treatment plant with other plant wastes. From there to outfall.	NA (after dewatering)
0432A	3	5495	Orifice scrubber	12.88	NA	2952 m^3/hr from orifice scrubber and seal and moisture separator together with 193 m^3/hr from sinter plant and 45.4 m^3/hr from hot metal desulfurizer to: Grit chamber, thickener, alkaline chlorination, polymer addition and 2nd thickener.	0	Outfall.	Sinter plant (both thickeners)
0684H	1	2295	Venturi, washer, WESP	9.78	River.	Aeration, lime, chlorine, polymer addition, settling.	88	POTW and sludge.	Briquetting plant
0946A	2	2175	NA	22.5	NA	Settling with sinter plant wastes, alkaline chlorination, filter with hot mill wastes.	(Calculated) 38	NA	NA
0196A	NA	NA	NA	4.63	NA	Clarifier, acid addition, cooling	NA	Combined with other plant wastes and treated at a central treatment facility	NA

NA - Not Available

Data from Development Document for Proposed Effluent Limitations Guidelines and Standards for the Iron and Steel Manufacturing Point Source Category. Vol. II EPA 440/1-80/024-b, December 1980. Tables VII-2,3,4 pp. 355-358.

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TABLE 5-6. U.S. BLAST FURNACE WASTEWATER TREATMENT EFFICIENCIES

A. RAW WASTEWATER

Plant	Water Applied m3/Mg (gal/ton)	Water Recycled m3/Mg (gal/ton)	Water Recycled %	Suspended Solids mg/l	Suspended Solids kg/Mg	Total CN mg/l	Total CN kg/Mg	Phenols mg/l	Phenols kg/Mg	Ammonia (as N) mg/l	Ammonia (as N) kg/Mg	Fluoride mg/l	Fluoride kg/Mg	pH
0946A	22.5 (5400)	8.33 (1998)	37	81	1.82	1.43	0.0322	0.132	0.00297	1.91	0.0430	0.64	0.0144	6.6
0448A	13.96 (3350)	13.55 (3250)	97	346	4.83	18.5	0.258	0.564	0.00787	227	3.17	12.7	0.177	6.6-6.7
0060F	13.02 (3123)	12.63 (3029)	97	1209	15.7	9.67	0.126	0.095	0.00124	85.5	1.11	17.7	0.230	7.4-7.5
0112D	6.53 (1567)	6.34 (1520)	97	512	3.34	0.054	0.000352	0.080	0.000522	57.9	0.378	15.6	0.102	6.4-7.1
0432A	12.89 (3091)	0	0	1643	21.1	12.1	0.156	3.02	0.0389	18	0.232	3.02	0.0389	9.4
0684H	9.49 (2277)	8.74 (2095)	92	1640	15.6	0.301	0.00285	2.50	0.0237	25	0.237	9	0.0853	10.2

B. TREATED WATER TO DISCHARGE

Plant	Water Discharged m3/Mg (gal/ton)	Suspended Solids mg/l	Suspended Solids kg/Mg	Total CN mg/l	Total CN kg/Mg	Phenols mg/l	Phenols kg/Mg	Ammonia (as N) mg/l	Ammonia (as N) kg/Mg	Fluoride mg/l	Fluoride kg/Mg	pH
0946A	14.19 (3402)	3	0.0372	0.005	0.000173	0.014	0.000363	0.806	0.0186	0.68	0.0116	7.6
0448A	0.41 (98)(1)	39	0.0163	17.3	0.00724	0.035	0.000015	225	0.0942	10.7	0.00448	6.7-8.1
0060F	0.39 (94)(1)	46	0.0199	10.8	0.00468	0.010	0.000004	82.2	0.0356	22	0.00954	8.0
0112D	0.19 (46)(1)	70.5	0.0215	0.049	0.000015	0.029	0.000009	43.7	0.0133	16.6	0.00505	7.3-7.5
0432A	12.89 (3091)(1)	38	0.431	1.11	0.0153	2.85	0.0392	20	-	3.2	0.0415	10.1-10.9
0684H	0.74 (178)(1)	44	0.0344	0.227	0.000178	2.00	0.00157	16	0.0125	7.9	0.00618	8.2-8.8

(1) Assuming 2 percent evaporative loss

Data from Development Document for Proposed Effluent Limitations and Standards for the Iron and Steel Manufacturing Point Source Category. Vol. II, EPA 440/1-80/024-b December 1980 Tables VII-2,3,4, pp. 355-358.

SECTION 6.0

COMPARISON OF UNITED STATES AND FOREIGN WASTEWATER TREATMENT PRACTICES

6.1 GENERAL

Wastewater treatment practices at foreign blast furnaces and coke plants studied have been compared to the practices utilized at similar production facilities in the United States. The base for comparison have been the degree of water recycle at blast furnaces and the quality of effluents from blast furnace and coke plant wastewater treatment systems. Effluent quality is judged on the concentration and mass of the pollutants discharged as specified by the U.S. EPA guidelines for both BPT and BAT levels (excluding priority pollutants). Table 6-1 has been prepared to show the degrees of BPT and BAT compliance for U.S. and foreign facilities.

The data in Table 6-1 shows that the BPT and BAT Guidelines for by-product coke plants and blast furnaces are being met at some foreign and U.S. plants for most parameters.

An indication of water use efficiency can be obtained by comparing the degrees of EPA concentration compliance to mass limitations. A larger portion of the foreign blast furnace treatment systems that meet the guidelines limitations at BAT levels with respect to concentrations also meet the guidelines limitations with respect to mass discharges for suspended solids and cyanide. This indicates that less water is being discharged per unit of production resulting in the lower mass discharges.

6.2 BY-PRODUCT COKE PLANTS

Nine of the fourteen foreign by-product coke plant biological treatment plants add dilution water to the raw wastewater and all fourteen add a nutrient, usually as phosphoric acid. All plants use the single stage activated sludge process. Two in Japan further treat the wastes by sand filtration and carbon adsorption. Two plants pretreat the wastes for removal of tars by filtering through a bed of coarse coke.

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TABLE 6-1. COMPARATIVE COMPLIANCE OF FOREIGN AND U.S. BY-PRODUCT COKE PLANT AND BLAST FURNACE WASTEWATER TREATMENT FACILITIES WITH U.S. EPA DRAFT EFFLUENT GUIDELINES FOR BPT AND BAT

Area	Coke Plant or Blast Furnace	Level of Treatment	Susp. Solids		Total Cyanide		Oil & Grease		Phenolics		Ammonia	
Foreign	Coke Plant	BPT	5		7		3		0		9	
			100%	100%	100%	100%	67%	67%	-	-	13%	22%
U.S.	"	"	6		6		5		3		6	
			83%	67%	100%	83%	60%	80%	33%	33%	50%	50%
Foreign	"	BAT	5		7		3		0		9	
			40%	80%	100%	86%	67%	67%	-	-	0	11%
U.S.	"	"	6		6		5		3		6	
			17%	17%	67%	17%	60%	80%	0	0	33%	17%
Foreign	Blast Furn.	BPT	12		12		0		0		4	
			83%	67%	100%	100%	-	-	-	-	100%	75%
U.S.	"	"	6		6		0		6		5	
			83%	50%	83%	33%	-	-	100%	83%	80%	80%
Foreign	"	BAT	12		12		0		0		4	
			8%	25%	42%	42%	-	-	-	-	0	0
U.S.	"	"	6		6		0		6		5	
			17%	0	50%	17%	-	-	67%	50%	20%	0

No. of plants for which data is available	
% that meet concentration limit	% that meet mass limit

NOTE: The data presented in this table are based on information from a limited number of plants.

The U.S. plants are only those for which data were available from the U.S. EPA Development Documents.

The data for foreign plants are for those that were visited during the course of the study and constituted plants thought to have superior technology.

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The volume of waste ammonia liquor produced at foreign plants ranges from 0.14 to 0.74 m^3/Mg (34 to 178 gallons per ton) of coke produced with an average of 0.28 m^3/Mg (67 gallons per ton). In the United States (on the basis of data available from six coke plants) the range of waste ammonia liquor production is from 0.11 to 0.24 m^3/Mg (26 to 58 gallons per ton) with an average of 0.15 m^3/Mg (36 gallons per ton). It may be that the moisture content of the coal used in the U.S. is lower than that used in foreign coke plants.

6.3 BLAST FURNACES

At 53 U.S. plants, with an average production of 239,500 Mg/day (264,000 tpd) of iron, the applied water rate for gas cleaning ranges from 2.2 to 50.8 m^3/Mg (532 to 12,126 gallons per ton). The nationwide weighted average is 12 m^3/Mg (2882 gpt). Discharges range from zero (supposedly 100 percent recycle) to 100 percent (once-through) of applied water. The nationwide average of recycle is some 42 percent. This includes the three plants that reported 100 percent. For the three plants that reported zero discharge, the quantity of water lost to miscellaneous leaks and drips, cooling tower drift, slag quenching etc. have not been considered so the percentage of discharge to applied water could be less than 100 percent.

All but one of the foreign installations have settling facilities for the gas washer water prior to discharge or reuse. The plant that does not provide settling, Hoogovens in the Netherlands, has plans for the installation and operation of thickeners by 1982.

The total production of iron at the foreign plants, where data was available, averages 185,666 Mg/day (204,660 tons per day). The gas washer water application rate ranges from 2.1 to 28 m^3/Mg (503 to 6715 gpt) with an average application rate of 6.09 m^3/Mg (1460 gpt). All plants recycle their gas washer except for Hoogovens in the Netherlands, a plant in Argentina and one in Australia. The recycle rate for plants that have recycle systems ranges from 27.4 percent to 99.2 percent, with an average of 82.9 percent. Plants that do not recycle are included. If the three non-recycle plants are excluded, the average recycle rate is 92.4 percent.

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The geographic distribution of recycle rates is:

Western Europe excluding non-recycle plant	92 %
Australia excluding non-recycle plant	89.5 %
Taiwan	99 %
Japan	91.3 %
Mexico	95.6 %
South Africa	96.6 %
United States	42 %

If all the foreign plants were included, these percentages would probably be considerably less. The plants selected for study were picked specifically because they were presumed to use advanced technology.

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SECTION 7.0

ADVANCED TECHNOLOGY

The primary purpose of this study was to determine if water use or wastewater treatment processes are more advanced technically at foreign steel plant, by-product coke plant and blast furnace operations than in the United States. If advanced technologies were found, their potential use in U.S. plants was to be evaluated by engineering analysis. Visits to 25 plants and supplementary data received from 23 of these 25 plants did not show than foreign treatment practices are more advanced that those in the U.S.

Some treatment practices and procedures that seemed superior to U.S. practice were observed but they are not considered applicable to domestic steel plants at this time. As a result, the objective of the project was modified. The information from the study,plus other available information, was to be used to propose treatment alternatives that are more advanced than existing practices in the U.S.

7.1 BY-PRODUCT COKE PLANT WASTEWATER TREATMENT

Twenty-one of 23 foreign by-product coke plants used free ammonia stills, the one single unit found most often in foreign mills. One plant without a free ammonia still uses the raw wastewater for quenching coke and the other plant uses the raw wastewater for irrigation of crops planted on company land. The crops are then sold to cattle farmers. No groundwater analyses were provided for the irrigated areas.

Fourteen plants use the activated sludge process and all add phosphorous compounds as nutrients. Eight of the fourteen plants add dilution water in varying direct proportions in the initial concentration of ammonia in the raw wastewater.

Two plants operate dephenolizers following the free ammonia stills. One plant discharges the dephenolized wastewaters to coke quenching and the other discharges to the Emscher River in West Germany. The entire Emscher River, which also receives wastewater from a variety of other industries and from approximately 2.5 million inhabitants, is treated in an activated sludge plant near its mouth. (19)

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The Emscher plant is designed to treat biologically 20 m^3/sec (455 mgd). It has a maximum capacity of 30 m^3/sec (685 mgd). The raw water has a BOD_5 of about 155 mg/l. Effluent BOD is supposed to be 25 mg/l or lower. The plant processes are racks, primary settling, aeration and secondary clarification.

Three of the Japanese activated sludge plants filter the effluent through sand. Two plants treat the sand filter effluent with activated carbon adsorption. Detailed analyses of the influent and effluent of these systems were not available. However, it was reported that these polishing steps are used to meet required COD effluent levels. The effluent COD requirement was not available. It is not known if other plants in Japan use these polishing steps.

The most difficult problem in the treatment of coke plant wastewater is the removal of ammonia to meet the proposed effluent guidelines limitations. Only one stage of aeration is employed at all the plants studied for this report. It has been proven at domestic municipal treatment plants that a second stage of aerobic biological treatment can effectively nitrify ammonia to nitrates and a further special treatment step can denitrify the wastewater. For the last stage a substrate addition, usually methanol, is required to provide a source of carbon for the organisms metabolizing the nitrified ammonia. Methanol may be required if nitrification only is desired.

Anaerobic treatment is presently being used for the removal of ammonia from some industrial wastewaters. Following the anaerobic step, standard aerobic activated sludge treatment could then remove other bioxidizable compounds. One disadvantage is that, in the bioxidation of cyanide during the aerobic process, ammonia is produced. However, the quantity of cyanide is usually small. When converted to ammonia, the total ammonia in the effluent will still be significantly less than the ammonia initially present in the raw wastewater.

7.2 BLAST FURNACE WASTEWATER TREATMENT

Blast furnace gas cleaning wastewater in the U.S. and abroad usually is treated to remove suspended solids. Only one foreign plant intentionally treated the wastewater blowdown to remove cyanide. The treatment provided at that plant (Pont-a-Mousson, France) is Caro's Acid (H_2SO_5) addition to batch discharges from a settling pond. This chemical oxidation of cyanide is automatically controlled by redox probes. Spannarhyttan, in Sweden, reduces cyanide by sparging steam into the wastewater. The steam injection is for freeze prevention since the one blast furnace plant operates only five days per week. The steam apparently strips the cyanide from the wastewater.

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Unplanned cyanide reduction was reported at three foreign plants. Two Hoesch Huttenwerke plants in West Germany reported cyanide reductions across their flue dust ponds. This cyanide reduction occurs between the influent, a thickener underflow sludge, and the effluent, the flue dust pond underdrain flow. One of these plants also adds alkaline cold mill sludge to the flue dust sludge. Sodium hydroxide is added to the flue dust sludge of the other blast furnace where cold mill sludge is not available. There has been no research to determine the mechanisms of cyanide reduction in these cases but the corporation hypothesizes that, under alkaline conditions, metallo-cyanide complexes are formed which are adsorbed on the surface of the flue dust particles as the water seeps through the sludge bed. Zinc reductions have also been noted.

At ISCOR's Pretoria Works, in South Africa, cyanide reduction was reported to occur in blowdown water after quenching slag. The reduction mechanism is not known but plant personnel believe the reduction is due to biological activity within the slag pile. However, due to the extremely high temperatures that the water is exposed to both in the gas streams and on the slag, the authors deem it unlikely that organisms can survive and be the cause of the cyanide reduction.

Water is recirculated in foreign blast furnace installations to a greater degree than in the United States. This is done of necessity because of shortages of water. Exceptions were noted at plants located near coastlines, such as Hoogovens in the Netherlands (which presently uses salt water) and at Hoskins-Kembla Works in Australia where once-through gas cleaning systems are operated.

A system for increasing water recirculation rates in gas washer systems was reported and observed at two steel plants, one in West Germany and one in Japan. The system (Fig. 7-1) consists of discharging the solids laden wastewater to a basin. It is aerated for approximately 12 minutes prior to settling in a clarifier. A polyelectrolyte is added to the clarifier influent to enhance settling of the solids. A portion of the settled solids is recirculated back to the aeration basin to act as a seed for calcium carbonate which precipitates during the aeration process. If necessary, lime may be added as a source of calcium and alkalinity. The mechanism is apparently carbon monoxide and carbon dioxide stripping which raises the pH. At the same time the water is cooled. This creates conditions favorable for the precipitation of calcium carbonate. This softening of the water prevents scaling in the recirculation system and allows higher recirculation rates.

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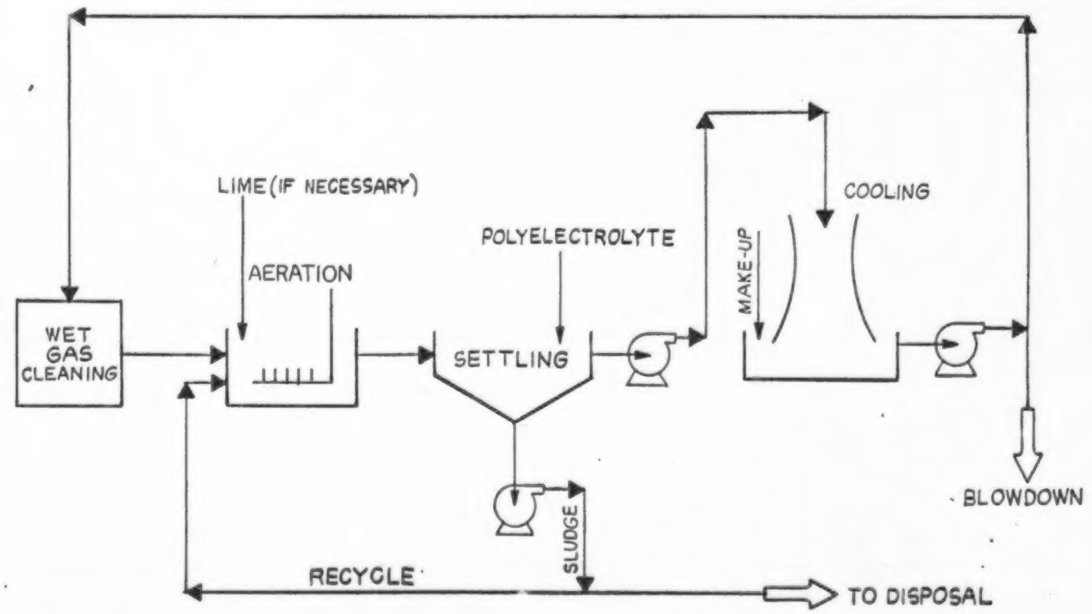
WET GAS CLEANING
LIME (IF NECESSARY)
AERATION
POLYELECTROLYTE
SETTLING
MAKE-UP
COOLING
BLOWDOWN
SLUDGE
RECYCLE
TO DISPOSAL

FIGURE 7-1 TYPICAL WEST GERMAN & JAPANESE BLAST FURNACE GAS WASHER WATER TREATMENT SYSTEM TO INCREASE RECIRCULATION

7.3 COMBINED TREATMENT OF BY-PRODUCT COKE PLANT AND BLAST FURNACE WASTEWATERS

The concept of treating combined wastewaters from by-product coke plants and blast furnaces in one system has not, to the authors knowledge, been tried anywhere in the iron and steel industry. Both wastewaters contain phenols and cyanides which are biodegradable. If a fixed ammonia still is not used, the coke by-product wastewater will have a relatively high concentration of ammonia. Dilution water must be added to reduce the concentration to a level that is not toxic to the organisms in a biological treatment plant. As the blast furnace wastewater contains phenols and cyanide to a lesser degree it also requires treatment and as it contains virtually no ammonia, it would seem logical to treat the two wastes in a common treatment system. The blast furnace wastewater would be the diluent.

However, blast furnace wastewater also contains metals which may be toxic to the biological mass. Pretreatment may be necessary to meet effluent requirements. Lime can be used to precipitate the toxic metals and also unregulated fluoride. After this pretreatment the blast furnace wastewater could be mixed with the by-product coke plant wastewater for combined phenol and cyanide treatment. At most integrated steel plants, blast furnaces and by-product coke plants are in relative close proximity to each other; any physical constraints to combining the waste streams would not be insurmountable.

If a fixed ammonia still, using lime, is used, the wastewater from the still is usually clarified to remove the excess lime. This excess lime can be used as a source of calcium to precipitate fluorides from the blast furnace blowdown. A complete conceptual system using two-stage aerobic biological treatment is shown on Fig. 7-2. A modification using anaerobic treatment for ammonia nitrification followed by aerobic treatment is shown on Fig. 7-3.(20)

The coke plant by-products wastewater treatment plant at Kaohsiung, Taiwan treats domestic sewage with coke plant wastewater. Adding blast furnace wastewater after pretreatment should not alter the compatibility of the mixture. All three can probably be treated in the same facilities.

An engineering design for the combined treatment of by-product coke plant and blast furnace gas washer wastewaters was prepared. The basis for the design was a greenfield plant with:

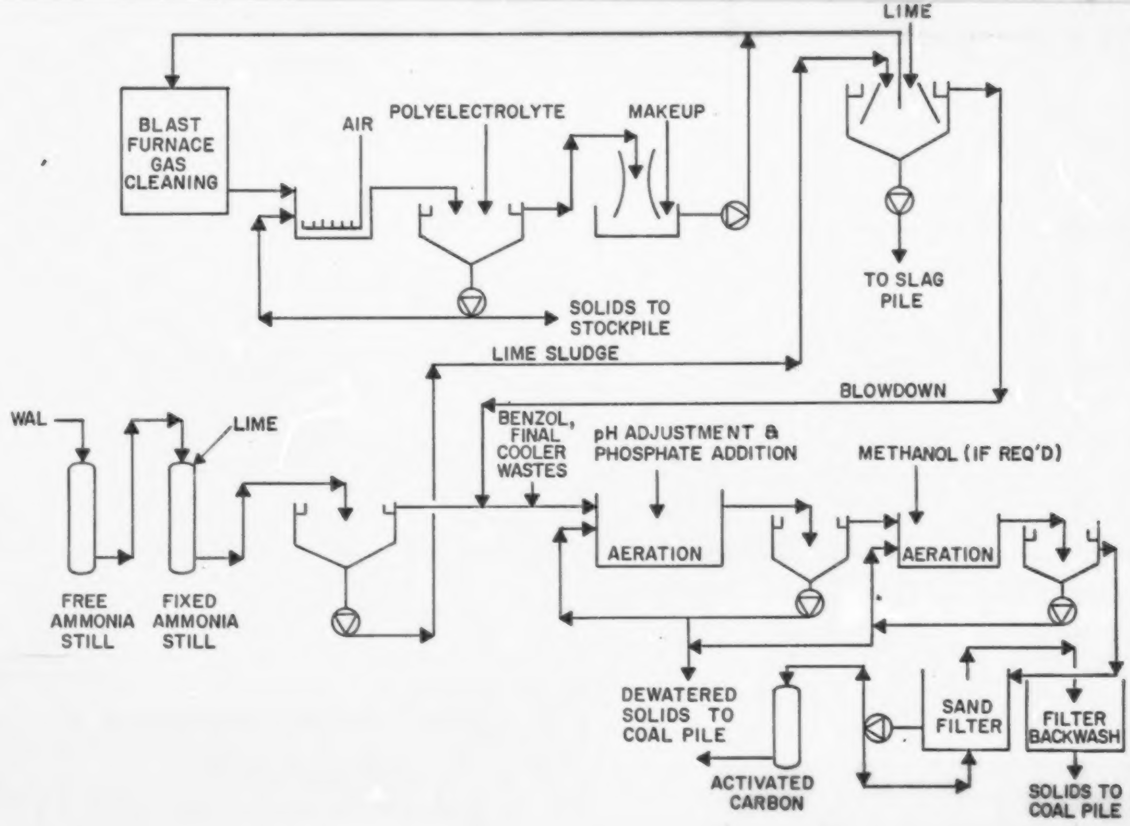
LIME
BLAST FURNACE GAS CLEANING
AIR
POLYELECTROLYTE
MAKEUP
TO SLAG PILE
SOLIDS TO STOCKPILE
LIME SLUDGE
BLOWDOWN
WAL
LIME
BENZOL, FINAL COOLER WASTES
pH ADJUSTMENT & PHOSPHATE ADDITION
METHANOL (IF REQ'D)
AERATION
AERATION
FREE AMMONIA STILL
FIXED AMMONIA STILL
DEWATERED SOLIDS TO COAL PILE
SAND FILTER
FILTER BACKWASH
ACTIVATED CARBON
SOLIDS TO COAL PILE

FIGURE 7-2 BY-PRODUCT COKE PLANT & BLAST FURNACE COMBINED WASTEWATER TREATMENT (AEROBIC BIOLOGICAL OXIDATION) FLOW DIAGRAM

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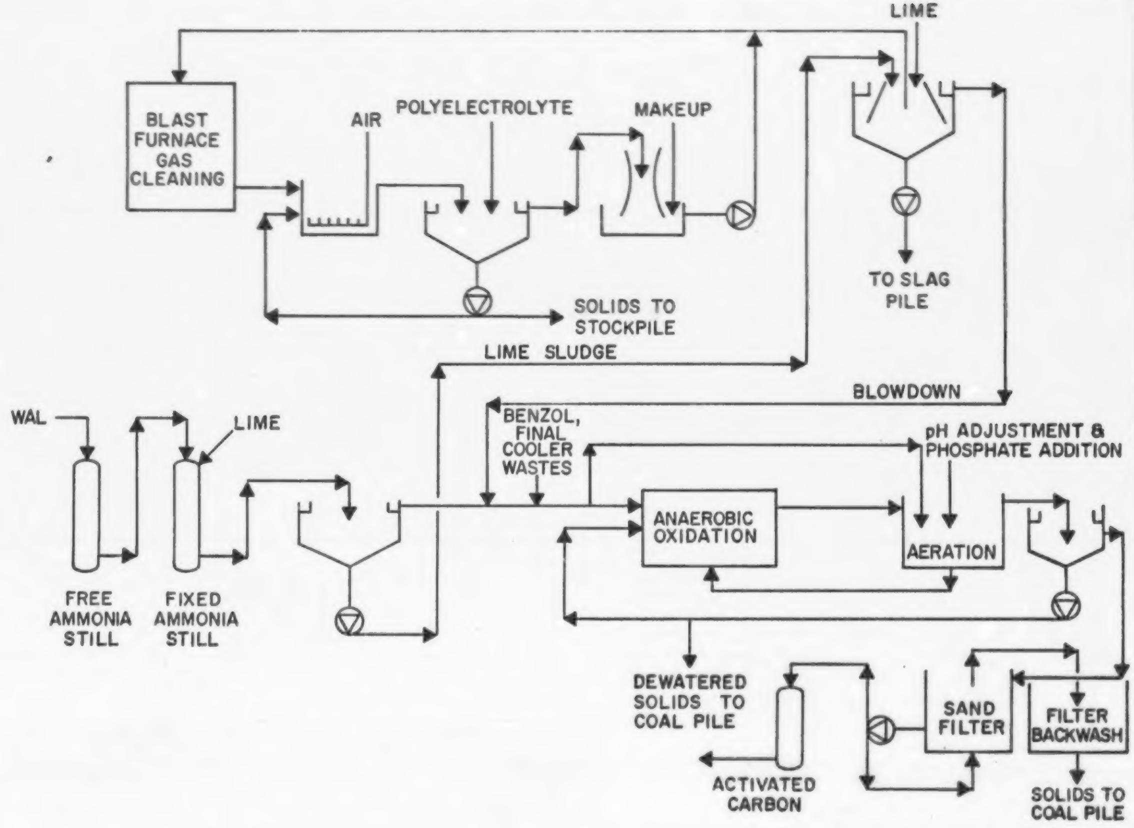
BLAST FURNACE GAS CLEANING
AIR
POLYELECTROLYTE
MAKEUP
LIME
TO SLAG PILE
SOLIDS TO STOCKPILE
LIME SLUDGE
BLOWDOWN
WAL
LIME
FREE AMMONIA STILL
FIXED AMMONIA STILL
BENZOL, FINAL COOLER WASTES
pH ADJUSTMENT & PHOSPHATE ADDITION
ANAEROBIC OXIDATION
AERATION
DEWATERED SOLIDS TO COAL PILE
ACTIVATED CARBON
SAND FILTER
FILTER BACKWASH
SOLIDS TO COAL PILE

FIGURE 7-3 BY-PRODUCT COKE PLANT & BLAST FURNACE COMBINED WASTEWATER TREATMENT (ANAEROBIC - AEROBIC BIOLOGICAL OXIDATION) FLOW DIAGRAM

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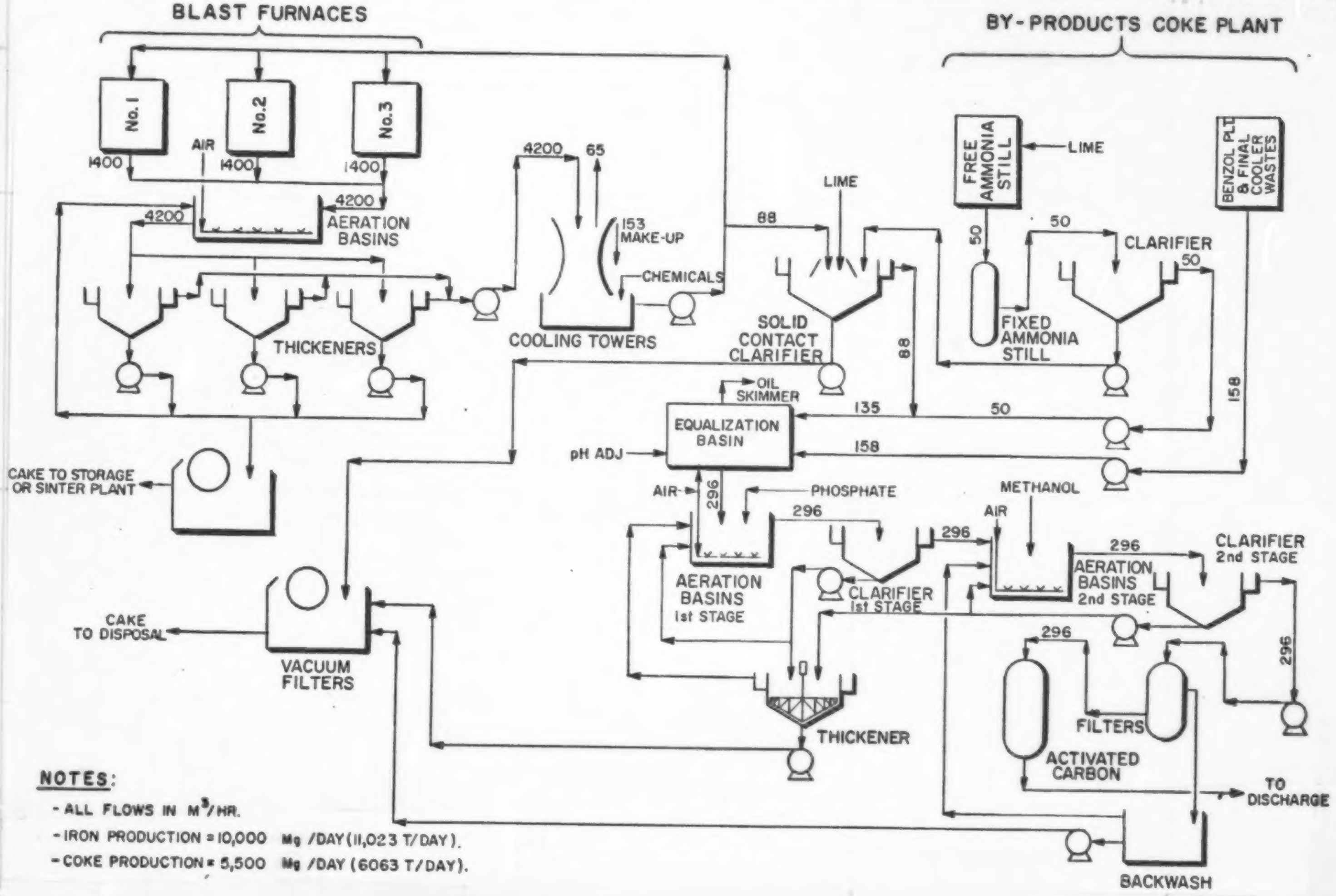
- Three blast furnaces producing a total of 10,000 Mg of iron (11,023 tons) per day.
- Four coke batteries producing a total of 5500 Mg of coke (6,063 tons) per day with one common by-product plant.
- Blast furnace gas washer flow assumed to be 10,141 l/Mg (2432 gal/ton) per furnace or, for this case, 4200 m^3/hr (18,480 gpm).
- Blast furnace blowdown assumed to be 210 l/Mg (50 gal/ton) or for this case 85 m^3/hr (374 gpm).
- Coke plant discharge based on 910 l/Mg (218 gal/ton) or production or a total of 208 m^3/hr (915 gpm).

Using the assumed production capacities a water and wastewater flow diagram of treatment and recirculation systems was prepared (Fig. 7-4). All necessary facilities for this system were designed and capital and annual costs estimated. A general arrangement of the blast furnace recirculation system is shown on Figure 7-5 and the centralized treatment area is shown on Figure 7-6. A location plan showing the relationship of the treatment facilities to the production facilities is shown on Fig. 7-7. The detailed cost estimates for the recirculation and treatment facilities are presented in Appendix C. Table 7-1 presents a summary of the capital and annual costs.

The capital cost for recirculation and wastewater treatment facilities is estimated to be $14,800,000. The annual cost is estimated at $3,846,000. On the basis of the assumed iron production of 10,000 Mg/day (4,000,000 t/yr), the estimated combined annual costs for blast furnace recirculation and combined wastewater treatment would be $1.06 per Mg ($0.96 per ton) of iron produced (which includes the necessary coke production) or $1.53 per m^3 ($5.79 per 1000 gallons) of wastewater treated for recirculation and/or discharge. The power requirement is estimated to be 1920 kilowatts and the energy requirement will be 6.69 kWh per m^3 (25.3 kWh per 1000 gallons).

7.4 AREAS OF RESEARCH

Many foreign steel plant personnel believe that the classical methods of blast furnace and by-product coke plant wastewater treatment (settling and biological treatment, respectively) were the only practical and economic treatment processes. Closer control of leakage, better housekeeping and strict control of water chemistry will lead to theoretical reductions in wastewater volume but off-normal conditions, which do occur, can elevate wastewater loads. Reductions in


BLAST FURNACES
No.1
No.2
No.3
AIR
1400
1400
1400
4200
4200
AERATION BASINS
THICKENERS
CAKE TO STORAGE OR SINTER PLANT
4200
65
153 MAKE-UP
CHEMICALS
COOLING TOWERS
88
LIME
SOLID CONTACT CLARIFIER
88
BY-PRODUCTS COKE PLANT
FREE AMMONIA STILL
LIME
50
50
FIXED AMMONIA STILL
CLARIFIER
50
BENZOL PLT & FINAL COOLER WASTES
158
OIL SKIMMER
EQUALIZATION BASIN
135
50
158
pH ADJ
AIR
296
PHOSPHATE
296
AERATION BASINS 1st STAGE
CLARIFIER 1st STAGE
296
METHANOL
AIR
AERATION BASINS 2nd STAGE
296
CLARIFIER 2nd STAGE
296
296
FILTERS
ACTIVATED CARBON
TO DISCHARGE
BACKWASH
THICKENER
VACUUM FILTERS
CAKE TO DISPOSAL

NOTES:

- ALL FLOWS IN M^3/HR.
- IRON PRODUCTION = 10,000 Mg /DAY (11,023 T/DAY).
- COKE PRODUCTION = 5,500 Mg /DAY (6063 T/DAY).

FIGURE 7-4 COMBINED BY-PRODUCT COKE PLANT & BLAST FURNACE WASTEWATER TREATMENT FACILITIES-FLOW DIAGRAM

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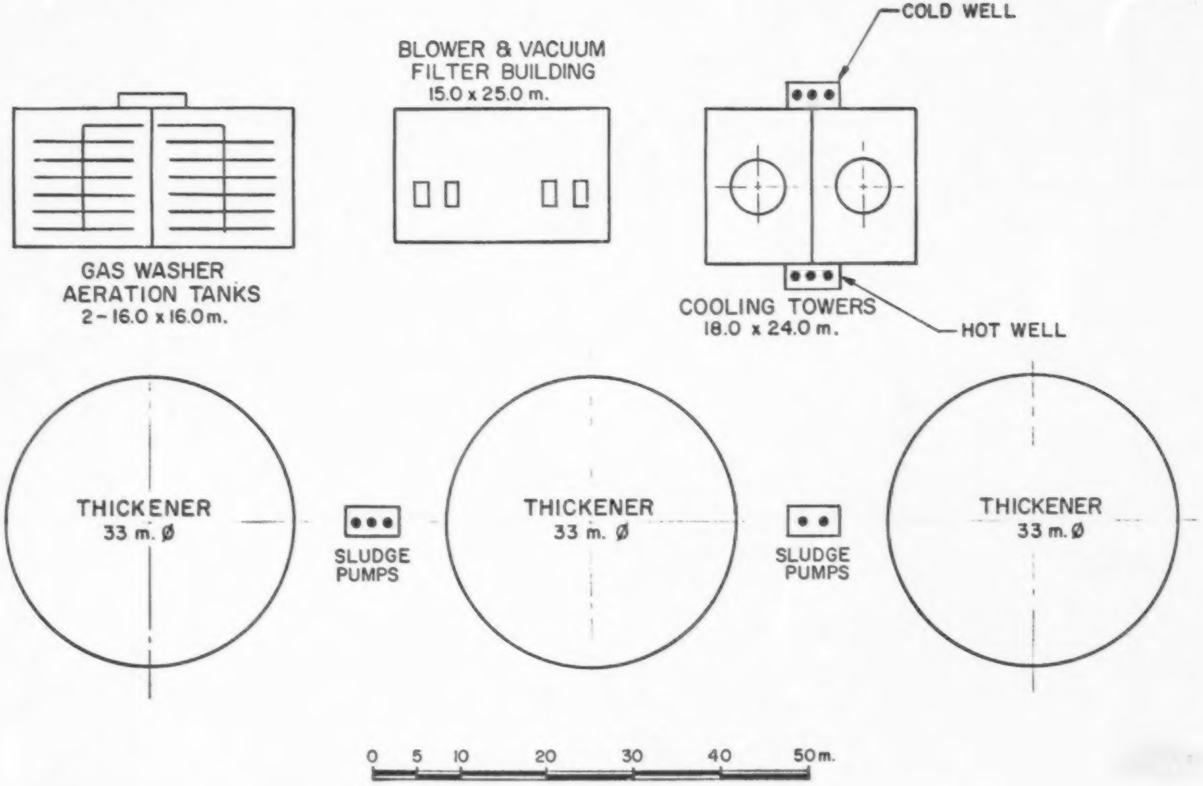
COLD WELL
BLOWER & VACUUM FILTER BUILDING
15.0 x 25.0 m.
GAS WASHER AERATION TANKS
2 - 16.0 x 16.0 m.
COOLING TOWERS
18.0 x 24.0 m.
HOT WELL
THICKENER
33 m. Ø
SLUDGE PUMPS
THICKENER
33 m. Ø
SLUDGE PUMPS
THICKENER
33 m. Ø
0
5
10
20
30
40
50 m.

FIGURE 7-5 BLAST FURNACE GAS WASHER RECIRCULATION SYSTEM LAYOUT (IRON PRODUCTION-10,000 Mg / DAY (11,023 T / DAY))

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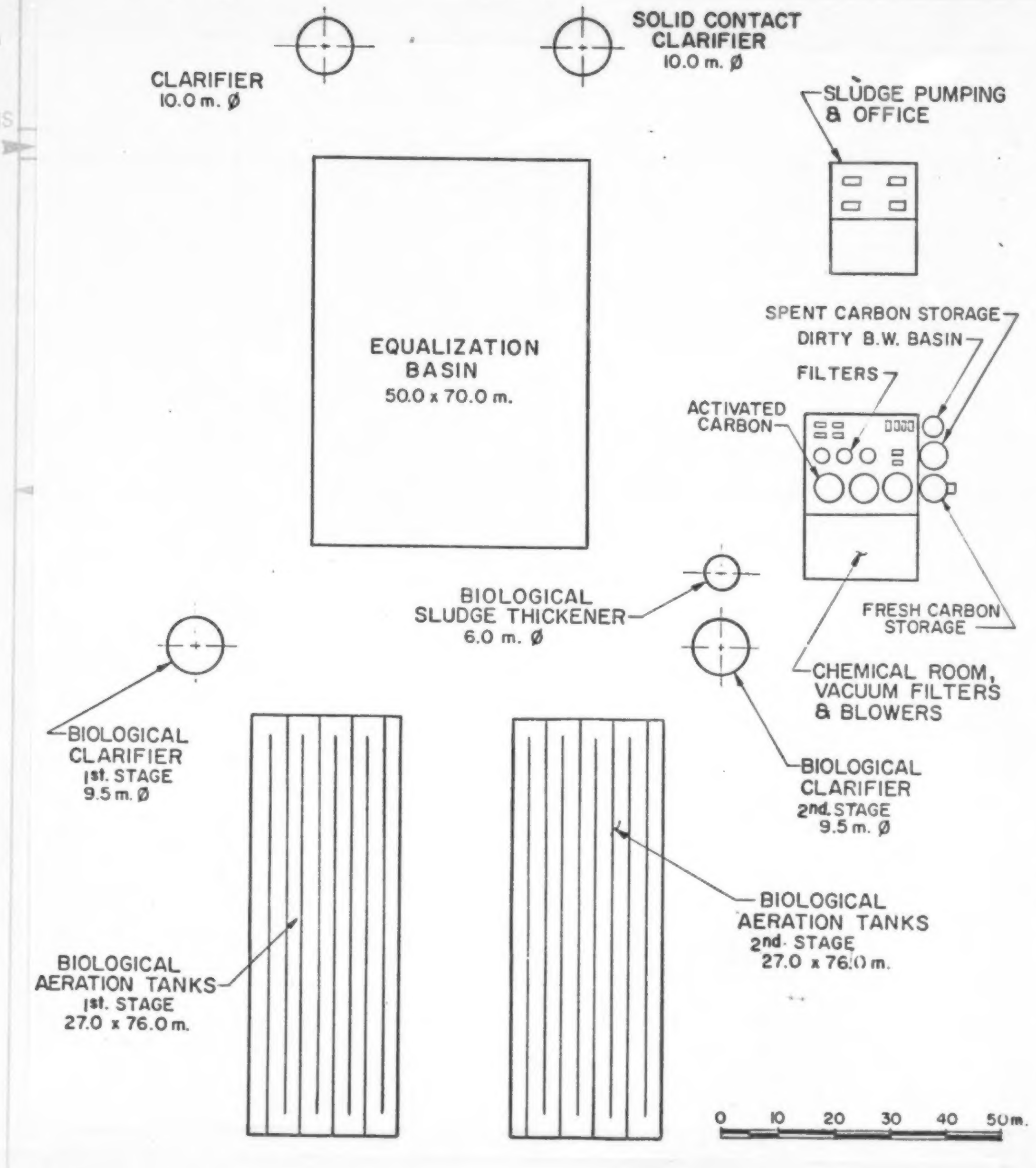
CLARIFIER
10.0 m. Ø
SOLID CONTACT CLARIFIER
10.0 m. Ø
SLUDGE PUMPING & OFFICE
EQUALIZATION BASIN
50.0 x 70.0 m.
SPENT CARBON STORAGE
DIRTY B.W. BASIN
FILTERS
ACTIVATED CARBON
BIOLOGICAL SLUDGE THICKENER
6.0 m. Ø
FRESH CARBON STORAGE
CHEMICAL ROOM, VACUUM FILTERS & BLOWERS
BIOLOGICAL CLARIFIER
1st. STAGE
9.5 m. Ø
BIOLOGICAL CLARIFIER
2nd. STAGE
9.5 m. Ø
BIOLOGICAL AERATION TANKS
2nd. STAGE
27.0 x 76.0 m.
BIOLOGICAL AERATION TANKS
1st. STAGE
27.0 x 76.0 m.
0
10
20
30
40
50m.

FIGURE 7-6 BY-PRODUCT COKE PLANT & BLAST FURNACE COMBINED WASTEWATER TREATMENT LAYOUT

NOTES:

- ALL FLOWS IN M^3/HR.
- IRON PRODUCTION = 10,000 Mg /DAY (11,023 T/DAY).
- COKE PRODUCTION = 5,500 Mg /DAY (6063 T/DAY).

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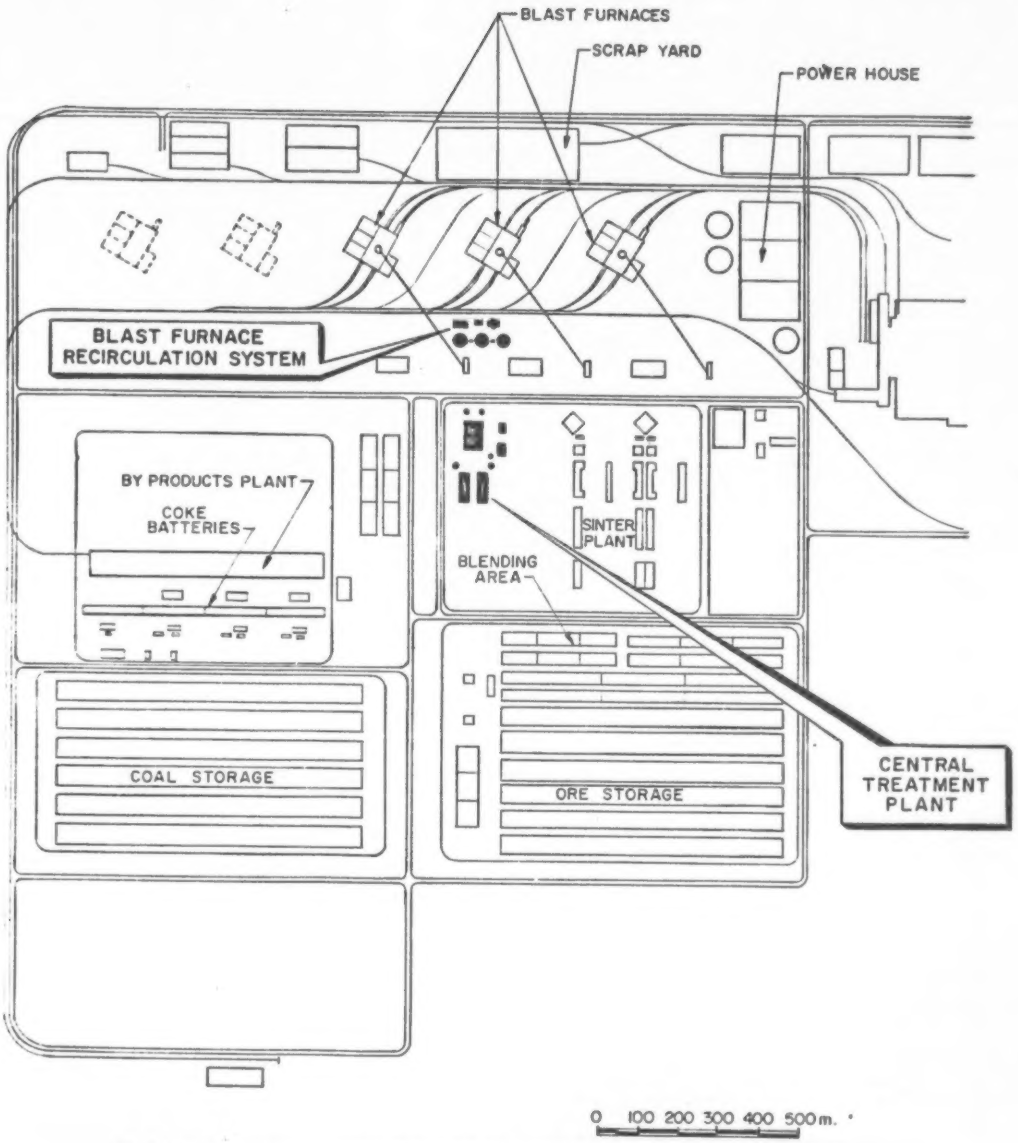
BLAST FURNACES
SCRAP YARD
POWER HOUSE
BLAST FURNACE RECIRCULATION SYSTEM
BY PRODUCTS PLANT
COKE BATTERIES
SINTER PLANT
BLENDING AREA
CENTRAL TREATMENT PLANT
COAL STORAGE
ORE STORAGE
0 100 200 300 400 500 m.

FIGURE 7-7 PRODUCTION FACILITIES LAYOUT
PRODUCTION FACILITIES LAYOUT
BY-PRODUCT COKE PLANT,
BLAST FURNACES AND
WASTEWATER TREATMENT FACILITIES

NOTE :
FACILITIES SHOWN SCHEMATICALLY ONLY.

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TABLE 7-1

COMBINED BY-PRODUCT COKE PLANT AND BLAST FURNACE WASTEWATER TREATMENT FACILITIES

SUMMARY OF COSTS*

1. Capital Costs

Blast Furnace Recirculation	$ 6,024,000
Coke Plant Pretreatment	869,000
Central Treatment Plant	7,899,000
Total Capital Costs	$14,782,000

2. Annual Costs for Total System

Amortization	$1,946,000	
O & M	1,900,000	
		$ 3,846,000

* For details, see Appendix C.

the size of treatment facilities may, therefore, be possible but handling of all off-normal flow rates must be considered.

No one thought that it was practical to completely "bottle-up" a blast furnace gas washer system and have no blowdown. Most thought that the blowdown could be minimized and could possibly be evaporated in quenching systems if there were no air pollution problems. The quenching of slag with blast furnace gas washer blowdown was an accepted practice in many foreign plants.

Certain phenomena were described that either improved effluent quality, improved treatment efficiency or enabled increased recycling. Quantitative information was not available on these phenomena. Research should be conducted to obtain the necessary data to determine if these phenomena are applicable to blast furnace and coke plant wastewater treatment throughout the world. The phenomena are as follows:

7.4.1 Cyanide Removal

Two methods of blast furnace wastewater disposal produce a reduction in cyanide concentration. This cyanide reduction did not result from design but is apparently incidental to the treatment of the wastewater.

1) The single blast furnace installation at Spannerhytten, Sweden, operates on a five-day a week basis to supply a steel plant with hot metal. In order to prevent freezing during shutdown periods, steam is sparged into the water system. Cyanide concentrations are reduced from 30 mg/l to 2.4 mg/l and the plant personnel assume this reduction is due to simple steam stripping. Hydrogen peroxide was used to attempt cyanide oxidation. This proved unsuccessful.

A research program should be undertaken to determine the reductions obtainable with steam injection and to determine the mechanism by which the cyanide is removed from the wastewater. A significant part of the research should be to determine the air pollution effects on this technique, and the economics (including energy requirements).

2) Unexpected cyanide reductions occur in the blast furnace gas washer water during treatment at Hoesch Huttenwerk in West Germany. The company has flue dust ponds at two separate blast furnace facilities. At one blast furnace installation, cold mill sludge is added to the flue dust sludge before it is discharged to the ponds. Sodium hydroxide is added at the other facility's ponds to maintain the pond water in an alkaline state. Ponds are operated alternately at each installation. Flue dust, sludges and chemicals are added at the tops of the ponds and the filtrates are collected by underdrains

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prior to discharge to a river. Analyses of influents and effluents were made and cyanide removals were noted.

The plant has hypothesized that the mechanism of cyanide removal is by the adsorption of metallo-cyanide complexes on the surface of the solids in the pond.

A research program should be undertaken to determine the degree of cyanide reduction by filtration through flue dust. If removals are significant, test should be run to obtain design criteria. The mechanism of cyanide removal should be investigated during the testing program so alternative treatment techniques can be explored.

At present, most steel companies do not recharge flue dust to their blast furnaces because of zinc and lead contamination. Research should be undertaken on air pollution by cyanide where the flue dust is sintered or briquetted and recharged and where the flue dust had been used as a filter medium to remove cyanide. One plant heats the flue dust to vaporize and remove contaminating zinc. This heating may also vaporize cyanide that has been picked up in the filtration process. Research may show either that the cyanide is destroyed by the heat or that it is being discharged as a vapor. The latter should be investigated if the cyanide is not completely destroyed by heat.

7.4.2 Increased Recirculation

At two blast furnaces, one in Japan and one in West Germany, increased gas washer water recirculation rates were achieved by aerating the gas cleaning water prior to settling in a clarifier or thickener. Softening is reported to take place. This permits increased recirculation by reducing the scaling potential. This system should be studied for application to U.S. blast furnace installation to reduce blowdown. The mobile pilot plant constructed by EPA's Industrial Environmental Research Laboratory - Research Triangle Park (IERL-RTP) should be used to investigate this unit operation to determine if further research is warranted. If the quantity of blowdown can be reduced, then it is clear that smaller wastewater treatment facilities would be required. The authors believe that this method holds promise and it has, therefore, been included as a unit operation in the treatment system shown on Figures 7-2 and 7-3.

7.4.3 Treatment of By-Product Coke Plant Wastewater

Nothing was seen or observed in the foreign steel plants that can be considered more advanced than any by-product coke plant wastewater treatment plant system presently operating in the United States or recommended in the draft Iron and Steel Effluent Guidelines Development Documents.

The authors have for a long time considered that coke plant wastewater can be combined with blast furnace gas cleaning blowdown water in a biological treatment plant. This concept was raised during discussions with steel plant personnel both in the United States and abroad. The only real objection raised was that the heavy metals present in the blast furnace wastewater would be toxic to the biological system. However, fluoride is also present in the blast furnace water, and lime precipitation is required to remove it. Lime will also form metallic hydroxides which will also, at the proper pH, precipitate. The removal of these precipitates should reduce heavy metals to levels below those toxic to biological systems. Therefore, the reduction of fluorides will be accompanied by a reduction in heavy metals and the wastewater should be amenable to biological treatment.

The IERL-RTP mobile pilot plant can be used to confirm that the metals levels remaining in the wastewater after lime precipitation will not be toxic to a biological system. The lime treated wastes should also be combined with coke plant wastewater consisting of: waste ammonia liquor treated in fixed and free ammonia stills and settling tanks for the removal of excess lime, final cooler wastes, and benzol plant wastes. This combined waste stream should then be treated biologically in the mobile pilot plant.

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GLOSSARY

Ammonia Liquor

Primarily water condensed from the coke oven gas, an aqueous solution of ammonium salts of which there are two kinds: free and fixed. The free salts are those which are decomposed on boiling to liberate ammonia. The fixed salts are those which require boiling with an alkali such as lime to liberate the ammonia.

Ammonia Still

The free ammonia still is simply a steam stripping operation where ammonia gas is removed from ammonia liquor. The fixed still is similar except lime is added to the liquor to force the combined ammonia out of its compounds so it can be steam stripped also.

Blast Furnace

A large, tall conical shaped furnace in which iron ore is reduced to iron.

Blowdown

Water intentionally discharged from a system to maintain water quality within the system.

BOD

Biochemical Oxygen Demand. The quantity of oxygen required to biologically oxidize organics contained in a wastewater stream.

By-Product Coke Process

Process in which coal is carbonized in the absence of air to produce coke and to permit recovery of the volatile compounds.

Cascading

The reuse of water discharged from one process to another process where lower quality water is acceptable.

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COD

Chemical Oxygen Demand. The quantity of oxygen that is consumed by the total oxidation of all oxidizable compounds contained in a waste stream.

Coke

The carbon residue left when the volatile matter is driven from coal by high temperature distillation.

Distillation

The vaporization and subsequent condensation of volatiles contained in coal during coke manufacture.

Drift

Water carried away from a cooling tower by wind.

Dustcatcher

A structure in which the blast furnace gases pass through and in which the major portion of the entrained dust is removed by mechanical separation.

Electrostatic Precipitator

A gas cleaning device electrically charging a solid particle which is then attracted to an oppositely charged collector plate. The collector plates are intermittently rapped or flushed to discharge the collected dust to a hopper below.

Flux

Material added to a process to remove impurities from hot metal.

Granulated Slag

A product made by dumping liquid blast furnace slag past a high pressure water jet and allowing it to fall into a pit of water. The material looks like light tan sand.

Light Oil

A clear yellow-brown oil with a specific gravity of about 0.889. It contains varying amounts of coal-gas products with boiling points from about 40°C to 200°C and from which benzene, toluene, xylene and solvent naphthas are recovered.

Quenching

A process of rapid cooling from an elevated temperature by contact with liquids, gases or solids.

Sinter

In blast furnace usage, lumpy material which has been prepared from flue dust. The dust is agglomerated by heating it to a high temperature. Sinter contains valuable amounts of combined iron.

Slag

A product resulting from the action of a flux on the nonmetallic constituents of a processed ore, or on the oxidized metallic constituents that are undesirable. Usually slags consist of combinations of acid oxides with basic oxides. Neutral oxides are added to aid fusibility.

Stoves

Large refractory filled vessels in which the air to be blown into the bottom of a blast furnace is preheated.

Venturi Scrubbers

A wet type collector that uses the throat for intermixing of the dust and water particles. The intermixing is accomplished by rapid contraction and expansion of the air stream and a high degree of turbulence.

Volatiles

Compounds vaporized from coal during the coking process.

Waste Heat Boiler

Boiler system which utilizes the hot gases as a source of heat.

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APPENDIX A

QUESTIONNAIRES

Blast Furnaces A-1

Coke Plants A-5

General A-11

100

BLAST FURNACES

How many blast furnaces are operating?

What is the average iron production (tonnes/day) each?

What wet gas cleaning systems are installed?

How much water do they use (m^3/hr)?

6-1/2"

What treatment is provided for the gas cleaning water?

Is the gas cleaning water recycled?

9-1/8"

If so, how much is recycled and how much is discharged?

Is the discharge water treated further?

If so, what treatment is provided?

Is any of the treated water reused?

What is the final disposition of the treated water?

What is the source of the makeup water to the gas cleaning system?

What is the disposition of solids produced?

What is the analysis of the ore used?

Please add any other comments or data that you feel may add to our understanding of your process.

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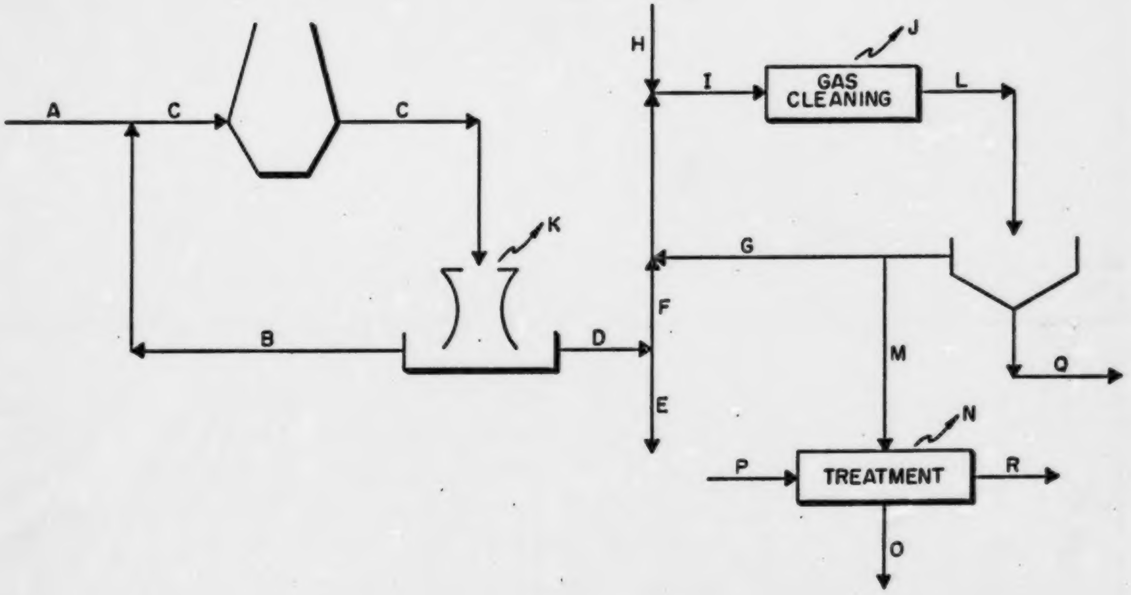
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BLAST FURNACE WATER SYSTEMS

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BLAST FURNACE

Page 1 of 2

LINE DESIGNATION (Refer to Attached Figure)	DESCRIPTION	QUANTITY (m^3/hr)	SOURCE	TO	ANALYSES OF WASTE FLOWS (concentrations, except pH, in mg/l)										
					pH	SS	CN	NH_3	$S^=$	Phenol	F	TDS	Other Analyses		
A	Non Contact Cooling Makeup			Furnace Cooling											
B	Cooled Water			Furnace Cooling											
C	Total to Cooling														
D	Cooling Blowdown														
E	Cooling Blowdown														
F	Cooling Blowdown			Gas Cleaning											
G	Recycled Cleaning			Gas Cleaning											
H	Cleaning Makeup			Gas Cleaning											
I	Total Cleaning														
J	Cleaning Evaporative Loss			Atmosphere	-	-	-	-	-	-	-	-	-	-	-

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BLAST FURNACE

LINE DESIGNATION (Refer to Attached Figure)	DESCRIPTION	QUANTITY (m^3/hr)	SOURCE	TO	ANALYSES OF WASTE FLOWS (concentrations, except pH, in mg/l)										
					pH	SS	CN	NH_3	S^-	Phenol	F	TDS	Other Analyses		
K	Cooling Evaporative Loss			Atmosphere	-	-	-	-	-	-	-	-	-	-	-
L	Cleaning Discharge			Flue Dust Settling											
M	Settling Blowdown			Treatment											
N	Treatment Loss				-	-	-	-	-	-	-	-	-	-	-
O	Treatment Discharge														
PA	Other Wastes			Treatment											
PB	Other Wastes														
PC	Other Wastes														
Q	Sludge				% of Solids:			Available Analysis of Sludge and Characteristics of Sludge:							
R	Sludge				% of Solids:			Available Analysis of Sludge and Characteristics of Sludge:							

EPA-287 (Cin.)
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COKE PLANT

How many coke oven batteries are normally operating?

How many ovens per battery?

What is the average coke production (tonnes/day)?

How much water is used to quench the coke (m^3/tonne)?

What are the sources of the water?

Is quench water recycled?

If not, where is the quench water discharged to and what is its quality?

What by-products are produced? (Phenolics, Ammonia, Tars, BTX, Naphthalene, etc.)

Do you operate a desulphurizer?

Do you operate a dephenolizer?

Do you operate ammonia strippers (free and fixed or free only)?

Are any air pollution control facilities installed that use water?

If so, what are the facilities and how much water is used (m^3/hr)?

What treatment is used for the coke plant wastes?

What are the sources and analyses of the wastes entering the treatment plant (weak ammonia liquor, scrubbers, desulphurizer, benzol plant, dilution water, etc.)?

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Is any of the treated water reused?

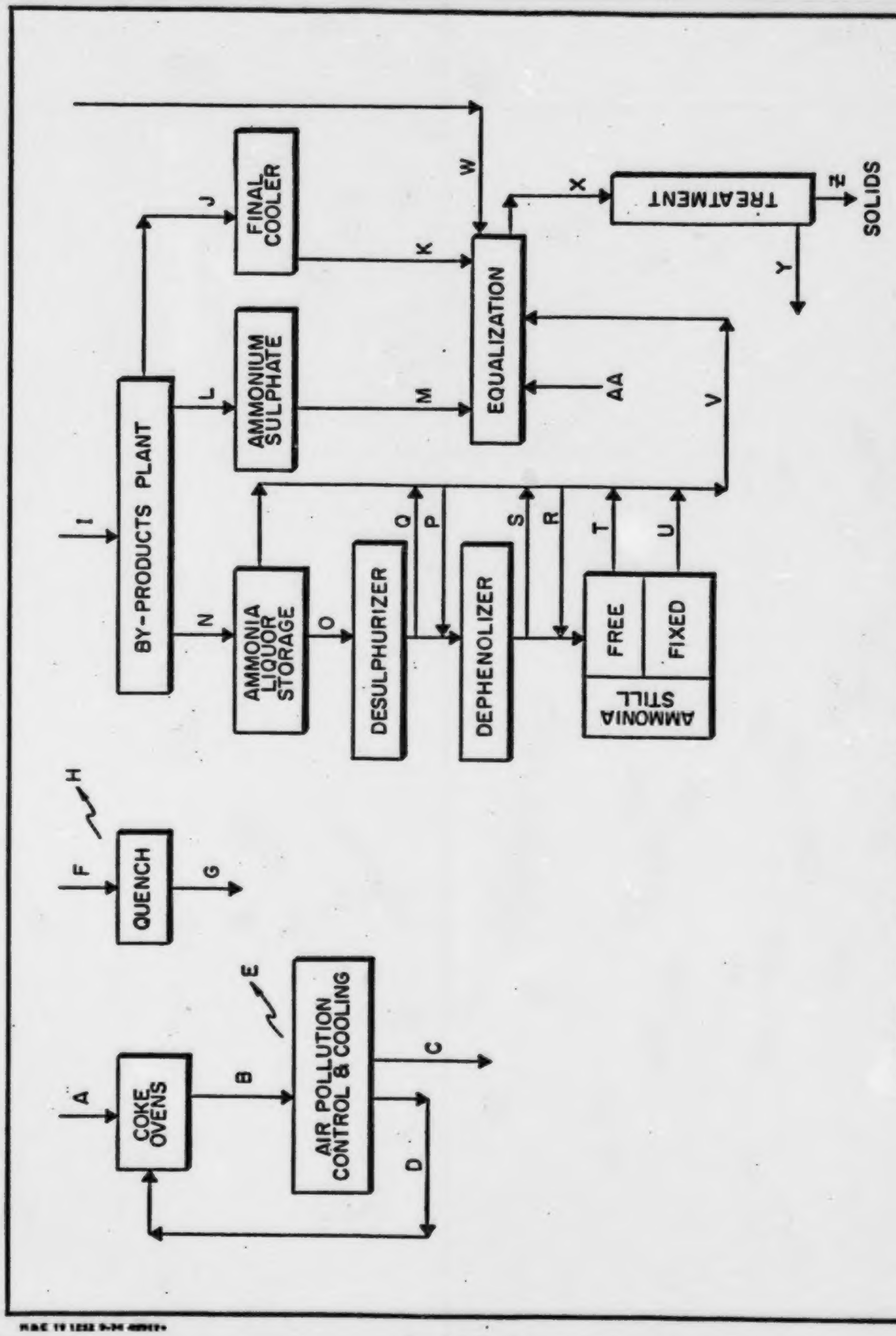
What is the final disposition of the treated water?

What is the disposition of the solids?

What is the analysis of the coal used?

Please add any other comments or data that you feel may add to our understanding of your process or differences in flow diagram as shown, such as if dephenolizer is located at a different point in the system.

EPA-287 (Cin.)
(4-76)


COKE OVENS
AIR POLLUTION CONTROL & COOLING
QUENCH
BY-PRODUCTS PLANT
AMMONIA LIQUOR STORAGE
DESULPHURIZER
DEPHENOLIZER
AMMONIA STILL
FREE
FIXED
AMMONIUM SULPHATE
FINAL COOLER
EQUALIZATION
TREATMENT
SOLIDS
A
B
C
D
E
F
G
H
I
J
K
L
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AA

COKE & BY-PRODUCTS PLANT WATER SYSTEMS

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COKE AND BY-PRODUCTS PLANT

Page 1 of 3

LINE DESIGNATION (Refer to Attached Figure)	DESCRIPTION	QUANTITY (m^3/hr)	SOURCE	TO	ANALYSES OF WASTE FLOWS (concentrations, except pH, in mg/l)										
					pH	SS	CN	NH_3	S^-	Phenol	Oils & Grease	TDS	Other Analyses		
A	Coke Oven Makeup														
B	Coke Oven Discharge														
C	Coke Oven Blowdown														
D	Coke Oven Recycle														
E	Coke Oven Evaporative Loss			Atmosphere	-	-	-	-	-	-	-	-	-	-	-
F	Quench Makeup														
G	Quench Discharge														
H	Quench Evaporative Loss			Atmosphere	-	-	-	-	-	-	-	-	-	-	-
I	By-Products Makeup														
J	Final Cooler Use														

EPA-287 (Cin.)
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COKE AND BY-PRODUCTS PLANT

Page 2 of 3

LINE DESIGNATION (Refer to Attached Figure)	DESCRIPTION	QUANTITY (m^3/hr)	SOURCE	TO	ANALYSES OF WASTE FLOWS (concentrations, except pH, in mg/l)										
					pH	SS	CN	NH_3	$S^=$	Phenol	Oils & Grease	TDS	Other Analyses		
K	Final Cooler Discharge														
L	Ammonium Sulphate Use														
M	Ammonium Sulphate Discharge														
N	Ammonia Liquor (WAL)														
O	WAL Desulphurized														
P	WAL Dephenolized														
Q	WAL Desulphurized and not Dephenolized														
R	WAL to Ammonia Still														
S	WAL Dephenolized and not Ammonia Stripped														
T	WAL Stripped of Free Ammonia Only														

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COKE AND BY-PRODUCTS PLANT

Page 3 of 3

LINE DESIGNATION (Refer to Attached Figure)	DESCRIPTION	QUANTITY (m^3/hr)	SOURCE	TO	ANALYSES OF WASTE FLOWS (concentrations, except pH, in mg/l)										
					pH	SS	CN	NH_3	S^-	Phenol	Oils & Grease	TDS	Other Analyses		
U	WAL Stripped of Free & Fixed Ammonia														
V	WAL Discharged														
W	Dilution Water														
X	Coke & By-Products Flow to Treatment			Treatment											
Y	Treated Discharge														
Z	Sludge				% of Solids:			Available Analysis of Sludge and Characteristics of Sludge:							
AA	Other Flows to Treatment														
BB	" " "														
CC	" " "														

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GENERAL

Are wastes from the coke plant, blast furnaces or both discharged to either a municipal sanitary waste treatment plant or to a joint industrial waste treatment plant?

If so, and if the information is available, would you please provide the following:

- Identification of other industries discharging their wastes to the treatment plant.
- If it is a municipal waste treatment plant, the population of the municipality.
- The average flow and analyses of the wastes entering the treatment plant.
- A description of the treatment provided.
- The analyses of the treated wastes discharged.

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APPENDIX B

PLANT TRIP REPORTS

		Plant	Page
Argentina	-	Argentinian Plant	1
Australia	-	AIS - Newcastle Works	3
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TRIP REPORT

HYDROTECHNIC CORPORATION

VISIT TO STEEL PLANT IN ARGENTINA

Subject: Study of superior non-U.S. technology for the treatment of coke plant and blast furnace wastes.

October 17, 1979

6-1/2"

Attending

For Hydrotechnic	(Plant requested annonymity)
H.J. Kohlmann H. Hofstein	

The steel plant visited in Argentina has two blast furnaces in operation: No. 1 with an average production of 2800 Mg (3080 tons) per day and No. 2 with an average production of 3100 Mg (3400 tons) per day.

Both blast furnaces utilize dry dust catchers as the first step in gas cleaning. Blast furnace 1 has two fixed throat venturi scrubbers and a gas washer following the dry dust catchers. The total water used for gas cleaning at both blast furnaces is 2000 m^3/hr (8800 gpm) and the solids laden water is discharged to one thickener. "Poly floccutan," a tannic acid based coagulant aid is added to enhance solids settling. After settling the water is discharged to the river without further treatment and the sludge withdrawn from the thickener is discharged to a pond which overflows to the river. The pond is cleaned periodically and the solids are used at the sinter plant. Analyses of the raw water, the gas cleaning water and the sludge were not available.

The coke plant has four coke oven batteries operating. Battery I has 44 ovens, Battery II has 45 ovens and Batteries III & IV have 40 ovens each. Batteries I & II produce a total of 1310 Mg (1440 tons) of coke per day and Batteries III & IV produce a total of 2162 Mg (2380 tons) of coke per day.

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The by-products plant produces crude tar, benzol, and ammonium sulfate. Service water supplied to the plant is obtained from the river which is filtered in "Immedium" filters.

Coke is quenched with recycled service water and the make-up requirement is from 1 to 1.4 m^3 per Mg (240 to 336 gal/ton).

Primary cooler water is on an open recycle system and 59.7 m^3/min (15,760 gpm) is applied. Approximately 0.83 m^3/min (220 gpm) is lost through evaporation and blowdown. The benzol scrubber also has an open recycle system with 4.5 m^3/min (1200 gpm) applied and a total loss of 0.14 m^3/hr (37 gpm). The coke oven gas is desulfurized.

The waste ammonia liquor is passed through free and fixed ammonia stills after which it is discharged. The volume and quality of the discharge was not provided. No air pollution control facilities requiring water are installed and treatment other than the ammonia stills is not provided for any of the wastewater.

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TRIP REPORT

HYDROTECHNIC CORPORATION

VISIT TO BROKEN HILL PROPRIETARY CO., LTD.
NEWCASTLE STEEL WORKS, NEWCASTLE, NEW SOUTH WALES, AUSTRALIA

Subject: Study of superior non-U.S. technology for the treatment of coke plant and blast furnace wastes.

May 7, 1979

Attending

For Newcastle	For Hydrotechnic
Mr. John Grogan	Mr. H. Hofstein
Mr. John Brewster	Mr. J. Chu

Blast Furnaces

Newcastle Steel Works operates four blast furnaces with average productions of 930 (1020), 1230 (1350), 1370 (1500) and 2200 (2420) (ton) per day. After dry dust catching the blast furnace gas is cleaned by wet methods. Blast furnaces 1, 2 and 3 use Brassert Towers and blast furnace 4 uses an orifice plate washer. All are followed by wet electrostatic precipitators. The total water use for gas cleaning is 1536 m^3/hr (6760 gpm). Until the early 1970's salt water was used on a once-through basis. It has since been replaced with a recirculating fresh water system. Sinter plant gas cleaning wastes are combined with the blast furnace gas cleaning system. The solids laden water is discharged to a 35 meter (115 ft) diameter by 4 meter (13 feet) deep thickener to which lime is added to control pH at 8.5 and to precipitate zinc and lead. Polyelectrolyte is added to enhance settling. 1537 m^3 (6700 gpm) is pumped over a cooling tower and recirculated back to the blast furnaces for gas cleaning.

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The blowdown from the system consists of 2.7 m^3/hr (12 gpm) of sludge pumped from the bottom of the thickener to an adjacent tank with an unspecified amount of coal washing water. The combined wastes at approximately 15 percent solids are pumped at a constant rate of 162 m^3/hr (710 gpm), regardless of blast furnace and coal washing operations, to a series of sludge ponds located on Kooragang Island in the Hunter River.

The sludge pond consists of numerous cells which are constructed of broken slag. Each cell is approximately 150 square meters (1600 ft^2). Water samples taken from observation wells outside of the slag dump show no zinc or lead present with manganese levels of from 2-3 mg/l. No analyses are performed for cyanide.

Makeup to the gas cleaning system is fresh water and reclaimed water from air compressor cooling and scale pit water from mills that are still on a once-through system.

The slag at blast furnace No. 4 is cooled with salt water. Excess water is discharged to the river with no recycle. The slag at blast furnaces 1, 2 and 3 is air cooled.

The blast furnace is cooled by two systems. One system, for the hearths, uses recycled fresh water which is cooled in heat exchangers by once-through salt water. The other system is direct once-through furnace cooling by salt water.

Typical water analyses provided are:

	pH	SS	CN	NH_3	TDS	Zn	Cl
Makeup water	7.0	-	-	-	-	-	60
Recycled Cleaning Water	8.3	20	0.3	100	3000	3	1200
Cleaning Water	7.5	300	1	200	2500	20	1000

(All values except pH in mg/l)

Coke Plant

The Newcastle Steel Works operates four coke oven batteries, two of which have 57 - 4 meter ovens, one with 36 - 6 meter ovens and one with 42 - 6 meter ovens. Their combined production is approximately 4000 Mg (4400 tons) per day.

In addition to coke, a by-product plant is operated which produces ammonium sulfate, tar, BTX and naphthalene.

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Approximately 30 m^3/hr (132 gpm) of excess ammonia liquor is passed through a free ammonia still. The stripped ammonia is used to produce ammonium sulfate and 37 m^3/hr of still bottoms are discharged to an effluent collection basin. The final cooler, cools by utilizing recirculated oil which, in turn, is cooled in a heat exchanger. The heat exchanger coolant is water which is cooled in a cooling tower and recirculated. Approximately 5 m^3/hr (22 gpm) of condensate from the final coolers is discharged to the effluent collection basin. Other discharges to the effluent collection basin are 5 m^3/hr (22 gpm) of leakage from the coke batteries, 15 m^3/hr (66 gpm) of excess water from the benzol plant and 1 m^3/hr (4.4 gpm) from the tar tank farm.

Charging cars on two batteries use 2.5 m^3/hr (11 gpm) for fugitive emission control and the coke side of two batteries have wet fume collection facilities that utilize 10 m^3/hr (44 gpm). The two systems are tied together. 15 m^3/hr (66 gpm) of excess water is supplied to the systems which is discharged as makeup to coke quenching.

The entire effluent collection basin flow of 63 m^3/hr (277 gpm) is discharged as additional makeup to the coke quenching system.

Approximately 100 m^3/hr (440 gpm) of water, as a daily average, is evaporated (0.6 m^3/ Mg (144 gal/ton)) during quenching. Additional water required in the amount of 22 m^3/hr (97 gpm) is recovered fresh water.

Typical water analyses provided are:

	pH	CN	NH_3	Phenol	CNS	Cl^-	$SO_4^=$
Excess Ammonia Liquor	9.3	100	3300	350	380	1200	-
Ammonia Still Discharge	8.7	31	1400	340	335	700	-
Recovered Fresh Water	7.0	-	-	-	-	60	-
Final Cooler Discharge	8.2	350	1100	120	210	40	104

All values except pH in mg/l.

The analyses and flows for both the blast furnace and coke plant systems are typical and there is some variation from day to day.

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TRIP REPORT

HYDROTECHNIC CORPORATION

VISIT TO AUSTRALIAN IRON & STEEL PTY. LTD.

HOSKINS-KEMBLA WORKS

PORT KEMBLA, NEW SOUTH WALES, AUSTRALIA

Subject: Study of superior non-U.S. technology for the treatment of coke plant and blast furnace wastes

May 9, 1979

Attending

For AIS

Mr. J.N. Gaynor
Mr. D. Hodges
Mr. A. O'Brien
Mr. B. Clift
Mr. P. Snowden
Mr. G. Crayford
Mr. B. Davies

For Hydrotechnic

Mr. H. Hofstein
Mr. J. Chu

Blast Furnaces

Australian Iron and Steel Pty. Ltd., Hoskins-Kembla Works, has five blast furnaces installed, of which four normally operate. Table HK-1 presents a summary of the production, gas cleaning methods and the gas cleaning water requirements at each operating furnace.

Gas cleaning water is used on a once-through basis. Salt water is supplied, used, treated for suspended solids removal and discharged. The treatment consists of gravity settling in either a thickener or a reactor-clarifier. The settled water from blast furnaces 2, 3 and 4 are discharged after treatment. The settled water from blast furnace 5 is used for slag cooling after which it is resettled and discharged. The slag pits act as a backup to the blast furnace 5 reactor-clarifier.

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TABLE HK - 1

BLAST FURNACES GAS CLEANING SYSTEMS

Blast Furnace No.	Daily Production (Mg (tons)/day)	Gas Cleaning Method Dry Dust Catcher Plus	Water Use (m^3/hr (gpm))
2	2,400 (2,640)	Orifice washer Brassert Wet electrostatic precipitators	1,800 (7,920)
3	2,700 (2,970)	Venturi scrubber Brassert Wet electrostatic precipitators	
4	3,000 (3,300)	Brassert Wet electrostatic precipitators	750 (3,300)
5	5,100 (5,610) to be increased to 6,000 (6,600)	Venturi scrubber Wet electrostatic precipitators	450 (1,980)

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The 27.5 meter (90 ft) diameter thickener for blast furnaces 2 and 3 receives approximately 1800 m^3/hr (7920 gpm) of solids laden water. The overflow is discharged to the Port Kembla inner harbor. Approximately 82 m^3/hr (360 gpm) of sludge underflow is pumped to the blast furnace 4 thickener. The 450 m^3/hr (1980 gpm) of salt water used for gas cleaning at blast furnace 5 is discharged to a 24.5 meter (80 ft) diameter thickener. Lime to raise the pH to 8.5 is added and polyelectrolytes, if necessary. The overflow is used to quench slag and the excess is discharged to two settling ponds before being discharged to Allens Creek. The slag ponds act as a backup to the blast furnace 5 reactor clarifier. The sludge underflow of approximately 68 m^3/hr (300 gpm) is discharged to blast furnace 4 thickener.

A third blast furnace thickener, 27.5 meters (120 ft) in diameter, receives the 750 m^3/hr (3300 gpm) of gas cleaning wastes from blast furnace 4, as well as wastes from the sinter plant, 82 m^3/hr (360 gpm) of sludge from blast furnaces 2 & 3 thickener, 68 m^3/hr (300 gpm) of sludge from the blast furnace 5 reactor-clarifier and 40 m^3/hr (176 gpm) of sludge from the BOS thickeners. The retention time is from 6 to 8 hours. Lime and polyelectrolyte are added. The overflow is to Allens Creek. Approximately 40 m^3/hr (176 gpm) of sludge underflow at approximately 5 percent solids is pumped to a final thickener where, with the addition of polyelectrolyte, the sludge is thickened to approximately 40 percent solids. The overflow is back to blast furnace 4 thickener and the sludge is pumped to a traveling belt filter where it is dewatered to approximately 60 percent solids. Filtrate is returned to blast furnace 4 thickener and the filter cake is used at the sinter plant. The plant is presently testing a solid bowl centrifuge to replace the filter and provide a solids cake of approximately 65 percent solids.

Figure HK-1 is a schematic flow diagram of the above blast furnace gas cleaning systems and Table HK-2 presents analyses of waters in the system.

The blast furnaces cooling water is recirculated with blowdowns consisting of incidental leakage. Makeup is fresh municipal water.

Coke Plant

The Hoskins-Kembla Works operates five coke oven batteries. One consists of 72 - 4 meter ovens, another consists of 96 - 4 meter ovens, two consist of 66 - 5 meter ovens each and the fifth consists of 101 - 5 meter ovens. Combined daily production is 8365 Mg (9200 tons) of coke.

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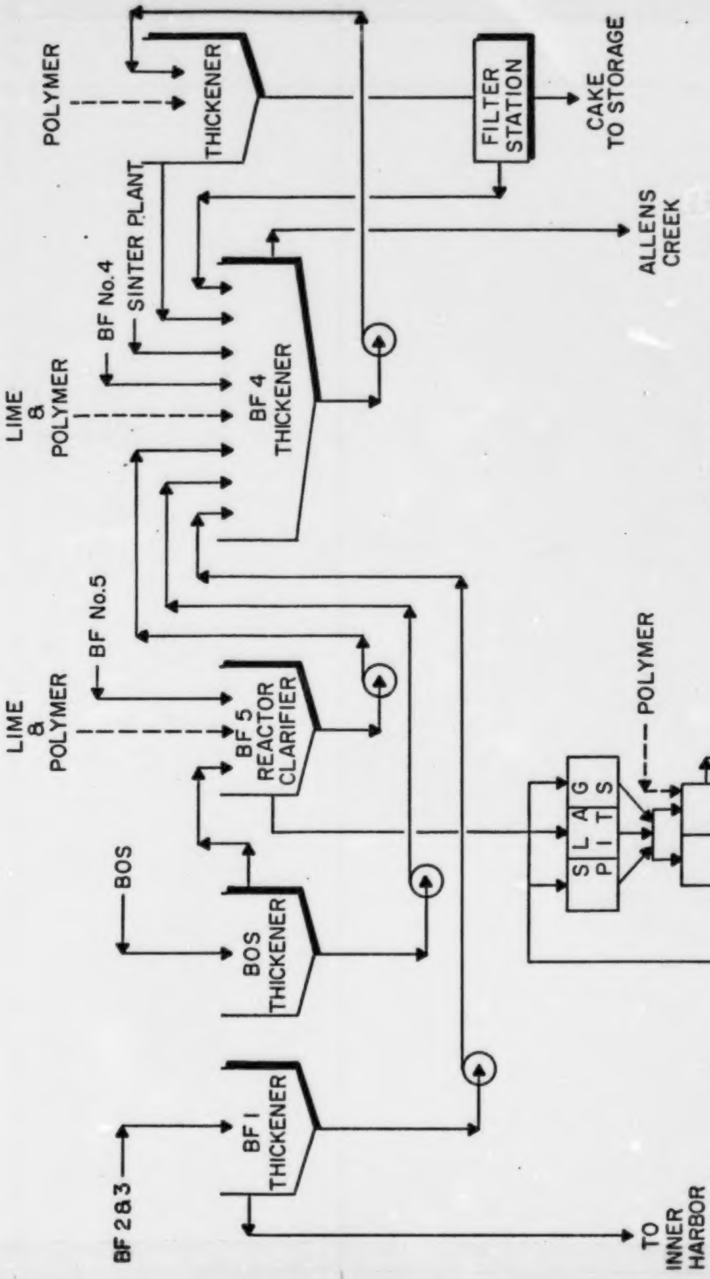
POLYMER
THICKENER
FILTER STATION
CAKE TO STORAGE
SINTER PLANT
BF No.4
ALLENS CREEK
LIME & POLYMER
BF 4 THICKENER
BF No.5
LIME & POLYMER
BF 5 REACTOR CLARIFIER
POLYMER
ALLENS CREEK
SLAG PITS
BOS
BOS THICKENER
BF 2 & 3
BF I THICKENER
TO INNER HARBOR

AIS PORT KEMBLA

BLAST FURNACE WASTE TREATMENT

FIG. HK-I

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TABLE HK-2
ANALYSES OF BLAST FURNACE GAS CLEANING WASTES
(All analyses except pH in mg/l)

	pH	SS	CN	NH_3	TDS	Total Fe	Sol Fe	Sol Zn*
Gas Cleaning Water Makeup	8.2	10	0.03	0.2	35,000	-	-	-
BF 2 & 3 Treated Discharge	7.0	40	-	-	-	5.1	2.1	5.5
BF 4 Treated Discharge	8.5	30	0.15	2.0	-	2.85	0.1	0.3
BF 5 Treated Discharge to Slag Pits	8.2	21	0.5-1.0	5	-	1.4	0.08	8.8
BF 4 to Treatment	7.6	5600	1.5			-	10	25
BF 5 Treatment	6.7	4000	2			-	10	35

* Soluble Zn from slag pit is 0.2 mg/l.

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The two by-product plants produce ammonium sulfate, tar, crude naphthalene and BTX.

Smokeless charging car scrubbers are installed at all batteries with a total water use of 30 m^3/hr (132 gpm). Each oven also has a water sealed stand pipe cap which requires 0.27 m^3/hr (1.2 gpm). These wastes go to the quencher. Waste ammonia liquor is discharged to two holding tanks prior to pumping to free ammonia stills. The ammonia from one of the stills which treats the wastes from batteries 4, 5 and 6 is incinerated. The ammonia from the second still from the remaining two batteries is a feedstock for ammonia sulfate production.

The stripped ammonia liquor (54 m^3/hr (238 gpm)) is discharged to the quench basins. Approximately 97 m^3/hr (427 gpm) of Benzol Plant discharge and 80 m^3/hr of fresh water is also added to the quench basins. Six cubic meters (1580 gal.) of water are required to quench each Mg of coke and 1 cubic meter (264 gal.) is evaporated. The 19 m^3/hr (84 gpm) average excess makeup over the evaporation requirement overflows periodically to the plant drain to the inner harbor.

Presently final gas cooling is by direct contact sea water which is discharged to the inner harbor. For one of the by-product plants indirect final coolers are being installed which will recirculate the cooling water and the condensate will be pumped to the flushing liquor decanter.

Table HK-3 presents analyses of various coke plant wastes.

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TABLE HK-3
COKE PLANT WASTEWATERS

(All analyses except pH in mg/l)

	pH	SS	CN	Free NH_3	Fixed NH_3	S	Phenol	Cl	TDS	O & G
Excess Ammonia Liquor to Still	9.3	-	40	2000	1000	50	260	-	-	
Excess Ammonia Liquor from Still	8.4	-	12	50	1000	28	150	-	-	
Quench Basin Discharge	-	20	3	(total NH_3 20)		-	-	500	-	
Benzol Plant	-	-	-	-	-	-	-	150	-	25
Final Cooler Makeup	8.2	10	0.03	(total NH_3 0.2)		-	-	-	35,000	10
Final Cooler Discharge	-	-	90	(total NH_3 8)		60	2	-	-	-
Ammonium Sulfate Discharge	-	-	-	(total NH_3 30)		-	0.2	-	-	-

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TRIP REPORT

HYDROTECHNIC CORPORATION

VISIT TO SIDMAR, GENT, BELGIUM

Subject: Study of superior non-U.S. technology for the treatment of coke plant and blast furnace wastes.

March 15, 1979

Attending

For SIDMAR	For Hydrotechnic	For U.S. EPA
Mr. Feldzer	Mr. H. Kohlmann	Mr. J. Ruppersberger
Mr. Verfaille	Mr. H. Hofstein	
Mr. Cousein		
Mr. Odul		

Coke Plant

SIDMAR operates two coke oven batteries each with 50 ovens. Coal is charged at a rate of 4730 Mg /day (5200 tons/day) (dry basis). Coking time is 16 hrs. Coal is reported to be approximately 25 percent volatiles, therefore the coke production is approximately 3500 Mg /day (3850 tons/day) in 150 pushes.

Coke is quenched in enclosed quench towers; each quench requires 60 m^3 (15,800 gallons) of water to be applied over a 1-1/2 minute period. As the incandescent coke enters the quench tower approximately 1 m^3 (264 gallons) of cole mills oil emulsion is sprayed over the coke which apparently lowers the moisture content of the coke to 2-3 percent. However, oil particles have been detected in the mist in addition to CH_2, C_2H_4 and C_2H_6 and therefore this method of disposal of cold mill wastes will be discontinued. Cold mill wastes will be treated by emulsion breaking. Of the 60 m^3 (15,800 gallons) of water applied approximately 22 m^3 (5800 gallons) is lost and not returned to the quench recycle system; 11.4 m^3 (3,010 gallons) is evaporated, 1.2 m^3 (317 gallons) remains in the coke, and 9.3 m^3 (2,455 gallons) is lost as mist and drained from the coke car. Two 75 m^3 (19,800 gallons) tanks are located on top

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of the quench towers that are filled by pumps from the quench tower settling basins. The settling basin consists of two 300 m^3 (79,200 gallons) and one baffled 250 m^3 (66,000 gallons) tanks operating in series and a fourth 190 m^3 (50,000 gallons) tank operated as a clear well for recycle pumps. Two pumps are 500 m^3/hr (2200 gpm) submersible pumps and a third 800 m^3/hr (3520 gpm) pump is in a dry well.

Makeup water is added at the pump well. The makeup water has a chloride content of approximately 3000 mg/l and the recycled water has a content of from 4000 to 5000 mg/l.

Because of the high chloride content various problems have been encountered; salt deposition in the vicinity of the towers and corrosion in the recirculationsystem and in the blast furnace gas cleaning system. It was stated that fluorides are also a problem in the makeup water.

The excess waste ammonia liquor (WAL) produced amounts to approximately 20 m^3/hr (88 gpm/hr) and is settled in a decanter and stored in a storage tank. The tar that settles out is further cleaned of entrained dust by a centrifuge after whcih it is sold. The removed dust is returned to the coal blending plant.

9-1/8"

At the present time 40 m^3/hr (176 gpm) of WAL is passed through a free ammonia still. 15 m^3/hr (66 gpm) is returned to the secondary wastes where an additional 5 m^3/hr (22 gpm) of water is added. The total of 20 m^3/hr (88 gpm) flows to the primary washer with secondary cooling water. 25 m^3/hr (110 gpm) of WAL is discharged to a biological plant. The NH_3 stripped from the WAL stream is burned to produce 8 Mg/hr of steam.

The stripped WAL is discharged to a 5 m x 29 m (16 ft x 95 ft) settling tank with a 10-hour detention time. From there it is discharged to a 4 m x 4 m (13 ft x 13 ft) aeration basin with a 3-hour detention time and then to a 4-1/2 m x 4-1/2 m (15 ft x 15 ft) settling tank with a detention time of 2-1/2 hours. Settled sludge is returned to the aeration tank. From the settling tank the wastes are discharged to a second aeration basin which is 14 m x 14 m (46 ft x 46 ft) and a 23-hour detention time. Discharge from the second aeration tank is to a 5 m x 29 m (16 ft x 95 ft) settling tank with a 10-hour detention time. The settled sludge is returned to the head end of the second aeration tank. Final settled wastes are discharged to the canal. Excess sludge is discharged to the coke quench basin on a batch basis to settle with the coke breeze and ultimately end up at the sinter plant.

Two analyses of waters at the biological treatment plant are shown below (all values except pH in mg/l):

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Parameter	Plant Influent	Plant Effluent
pH	7.87 & 8.27	7.40 & 7.87
COD	662 & 1632	180 & 488
BOD_5	398*	44
NH_4	527 & 1425	340 & 1020
H_2S	0	-
CN	3.72 & 4.37	0.62 & 1.66
CNS	84.2 & 192	5.87 & 95.8
S_2O_3	471 & 808	0 & 287
Phenol	100 & 248	1.02 & 19.7
PO_4	-	9 & 9
Fe	-	1.5 & 1.5

* Value corresponds to COD of 1632 influent and 488 effluent. (All values, except pH in mg/l).

It was pointed out during the visit that ammonia concentrations over 1000 mg/l kill the bio-mass in the system; therefore, dilution water is used when required and can be as high as one part dilution of water to 3 parts WAL.

Some phenol removal has been noted in the ammonia still.

The optimum temperature is 25-30°C.

NaH_2PO_4 is added as a nutrient and $FeSO_4$ is added for flocculation.

Future plans are for the plant to add a fixed ammonia still using lime and modify the gas washing operations by the addition of a desulphurizer. After modification, the operation will be as follows:

54 m^3/hr (238 gpm) of wash water will be passed through the existing free ammonia still. 38 m^3/hr (167 gpm) will be returned to a washer where 2 m^3/hr (9 gpm) of additional water will be added. This total of 40 m^3/hr (170 gpm) will flow to a first gas washer. The excess WAL of 14 m^3/hr (62 gpm) plus the 2 m^3/hr (9 gpm) of added water will be combined with 30 m^3/hr (132 gpm) of secondary cooler water and passed through a fixed ammonia still where steam and $Ca(OH)_2$ will be added. The total waste flow of 46 m^3/hr (202 gpm) will be discharged to a clarifier to settle the excess lime and the water will then be discharged to the biological plant described above. It is expected that the discharge will meet the following criteria:

pH	6.5-9	Phenol (tot)	5 mg/l
Temp.	30°C	CN (amenable to chlorination)	1 mg/l
BOD_5	67 mg/l		
COD	335 mg/l	F	5 mg/l
$N-NH_4$	250 mg/l	S (H_2S)	5 mg/l

It is expected that the revised system will be controlled to maintain the temperature at 25-30°C.

The addition of mist eliminators and baffles is also planned for the quench towers. The quench basin will also be increased in size, increasing the quench water and decreasing thereby the quench time.

Also in the future, approximately 100 m^3/hr (440 gpm) of coke plant cooling water will be blown down to a lagoon common with the blast furnace cooling water to control chloride levels and reduce corrosion.

Blast Furnaces

SIDMAR operates two blast furnaces, one (BF A) with a capacity of 5000 Mg/day and the other (BF B) with a capacity of 4000 Mg/day. Actual averages are 3800 and 3700 Mg /day (4180 and 4070 tons/day) respectively.

BF A uses a Bishoff washer with a water requirement of 1170 m^3/hr (5150 gpm). BF B uses a spray and venturi with a requirement of 1100 m^3/hr (4400 gpm). An electrostatic precipitator is used at BF B to remove excess water from the gas stream. BF A recirculates 320 m^3/hr (1410 gpm) and BF B recirculates 350 m^3/hr (1540 gpm) directly and the balances of 785 and 880 m^3/hr (3454 and 3872 gpm) are discharged to clarifiers at their respective furnaces. Supernatant is discharged to cooling towers and plant reservoirs. When the normal supply is not adequate, water from the BF B settling facility is used for slag granulation. Water from the reservoirs is discharged to the Gent-Terneuzen Canal. At the present time the gas cleaning water discharged is not treated any further, but with future regulations of SS of 80 mg/l and CN of 0.5 mg/l treatment may be required. The plant is considering the use of polyelectrolytes in the blast furnace settlers. They are also considering the possibility of using sodium hexametaphosphate for CN removal.

Analyses of water ranges at the blast furnaces are as follows (all values except pH in mg/l):

	Industrial Water	Thickener Discharges	
		BF A	BF B
pH	7-7.6	6.6	6.7
Tot. Hardness (as $CaCO_3$)	700-1700	1232	1252
Ca Hardness	350-1700	952	940
Mg Hardness	150-800	280	312
Cl^-	800-5200	2670	2357
SS	10-70	26-148	26-134
SO_4^{-2}	-	637	637

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Blast furnace non-contact cooling water is on closed systems at both furnaces. The total makeup requirements are approximately 1 m^3/hr (4.4 gpm) for each furnace.

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TRIP REPORT

HYDROTECHNIC CORPORATION

VISIT TO BRITISH STEEL CORPORATION, SCUNTHORPE WORKS

SCUNTHORPE, ENGLAND

Subject: Study of superior non-U.S. technology for the treatment of coke plant and blast furnace wastes.

March 27, 1979

6-1/2"

Attending

For British Steel Corp.	For Hydrotechnic
Mr. G.W. Cook	Mr. H. Hofstein
Mr. J. Wright	Mr. H. Kohlmann
Mr. R.B. Spencer	
	For U.S. EPA
	Mr. J. Ruppersberger

Blast Furnaces

Four blast furnace installations are operated at Scunthorpe Works: Apex, Seraphim, Redbourn and Normanby Park for a total of ten blast furnaces. The three smallest furnaces, at Redbourn, are to be phased out. Table I shows the production, gas cleaning units, wastewater treatment and sources of water at each of the installations. Treatment of the solids laden gas cleaning wastewater is by settling in clarifiers. Table II shows the quality of recirculating water in the gas cleaning systems.

The settled sludge is pumped to two settling lagoons and the settled solids are transferred to an area of nearby worked out ore mines. At one time the water was lost through evaporation and percolation, but now the supernatant has to be treated prior to discharge. The treatment is to be together with purges from the Apex and Seraphim blast furnaces and the new BOS gas

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TABLE I
SCUNTHORPE WORKS
BLAST FURNACE GAS CLEANING SYSTEMS

	Appleby Frodingham			
	Apex	Seraphim	Redbourn	Normanby Park
Number of Blast Furnaces	2	2	3	3
Average Production (tons/week)	2 @ 10,000	2 @ 12,000	3 @ 3,000*	1 @ 9,000, 2 @ 3,000-6,000
Gas Cleaning Units:				
Orifice Scrubbers	1	3	-	-
Washers	5	3	6	6
Electrostatic Precip.	4	7	6	6
Other	4 Disintegrators	-	-	-
Average Volume of Water Circulated (Imp. gal./min)	5,000	6,300	5,000	5,000
Clarifiers Installed:				
Size & Capacity (Imp. gals.)	2 @ 100' dia,11'3" deep 350,000 1 @ 70' dia, 20' deep 350,000	3 @ 100' dia,18'6" deep 550,000	1 @ 105' dia, 21' deep 1,000,000 1 @ 100' dia, 22' deep 1,000,000	2 @ 90' dia, 12' deep 300,000 1 @ 90' dia, 18' deep 550,000
Blowdown:				
Sludge (Imp. gal./min)	70	80	80	100
Water	None	35	None	150
Makeup Water:				
Source	River Ancholme	Ashby Ville	River Trent	River Trent
Type	Lime Softened	Sewage	Lime Softened	Settled
Avg. Quantity (Imp. gal./min)	100	200	150	300
	Purge fr. BF Cool., 70	Purge fr. Turboblowers, 40		

* To be phased out.

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TABLE II

SCUNTHORPE WORKS

ANALYSIS OF WATER IN B.F. GAS CLEANING SYSTEMS

Constituent	APPLEBY-FRODINGHAM				Redbourn		Normanby Park	
	Apex		Seraphim					
	Typical	General Range	Typical	General Range	Typical	General Range	Typical	General Range
pH Value	8.3	8.0-8.8	8.3	8.0-8.8	8.2	7.9-8.5	7.6	6.9-7.9
	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Suspended Solids: Before clarifier	510	200-1,500	550	200-1,500	380	250-1,750	350	150-700
After clarifier	50	30-100	55	40-100	50	30-90	100	60-150
Total Dissolved Solids	10,000	5,000-20,000	10,000	5,000-20,000	10,000	5,000-15,000	3,200	2,500-4,000
'P' Alkalinity as $CaCO_3$	150	nil-1,000	150	nil-1,000	200	nil-500	nil	-
'M' Alkalinity as $CaCO_3$	1,500	500-10,000	1,500	500-10,000	4,000	2,000-7,000	700	300-1,500
Total Hardness as $CaCO_3$	1,000	400-2,000	1,000	700-2,500	600	400-1,000	900	700-1,200
Chlorides as Cl	1,300	700-3,000	1,500	1,000-3,500	1,000	500-2,000	600	400-1,200
Free Cyanide as CN	10	5-20	10	5-20	10	2-25	5	3-30
Thiocyanate as CNS	70	20-150	60	10-150	50	30-200	15	10-50
Dissolved Fluoride as F	60	20-100	70	30-100	70	40-100	20	10-30
Dissolved Zinc as Zn	5	1-15	15	5-35	5	1-15	10	5-20
Dissolved Lead as Pb	0.8	0.5-3.0	1.0	0.5-3.0	0.4	0.2-1.0	0.4	0.2-1.0

TABLE III

SCUNTHORPE WORKS

TYPICAL ANALYSES OF THE DIFFERENT WATERS USED AS MAKE-UP INTO THE B.F. GAS CLEANING SYSTEMS

Constituent	River Ancholme (Lime Softened)	Ashby Ville (Sewage Effluent)	River Trent (Settled)	River Trent (Lime Softened)	Purge from Blast Furnace Cooling System	Purge from Turbo Blower Condenser Cooling System
Suspended Solids	< 5	14	25	<5	30	20
Total Dissolved Solids	650	900	810	700	1300	2400
Chloride as Cl	80	120	130	130	250	400
Total Hardness as $CaCO_3$	330	350	420	300	650	1150
Alkaline Hardness as $CaCO_3$	50	160	165	75	80	70
Calcium Hardness as $CaCO_3$	280	320	320	250	470	1000
pH Value	10.3	7.6	7.8	10.2	8.1	8.1

Results expressed in mg/l except pH value cleaning system. The treatment is to be in reactor clarifiers. Lime is added to the reactor clarifier feed to raise the pH to between 11.8 and 12.2 to establish suitable conditions for alkaline oxidation of the cyanide and for the precipitation of the zinc, lead and a major part of the fluoride. Chlorine is then added to the reactor section of the tank. The solids which are precipitated are pumped as a sludge to the blast furnace sludge lagoon and the settled water is fed through sand filters and discharged to a neutralization tank where sulfuric acid is added to lower the pH to between 5 and 9. The backwash water for the filters is drawn from the neutralization tank and discharged to a wash water tank from where it is pumped back to the reactor clarifier. When colloidal type solids are found, polyelectrolytes are used.

The quality anticipated to be achieved at the treatment plant effluent was:

SS	30 mg/l
F (diss.)	25 mg/l
Pb + Zn (tot. diss.)	1.0 mg/l
CN (uncomplexed)	0.1 mg/l (maximum)

but these values have never been achieved.

The consent conditions for the Seraphim Lagoon discharge are:

pH	5-9
SS	30 mg/l
BOD_5	20 mg/l
Free CN	0.1 mg/l
F	10 mg/l
4-hour Permanganate Value	20 mg/l
Total Dissolved Heavy Metals (As, Cd, Cr, Cu, Pb, Ni, Zn)	1.0 mg/l

As indicated in Table I the makeup at some blast furnace gas cleaning systems is with lime softened water. Typical analyses of blast furnace makeup water are shown on Table III. Chemical additions to control alkalinity and the scaling that had been encountered in the pipes and towers are: 77 percent sulfuric acid, phosphonates, polyphosphates, acrylates and other proprietary chemicals The polyphosphates do not destroy cyanide at Scunthorpe Works as has been reported at other plants.

All of the water not blown down either as sludge or water is recycled.

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The plant has experienced the production of CNS in the blast furnaces plus CN that is resistant to alkaline chlorination. Personnel at the plant are of the opinion that there may be a relationship between the actual rate of furnace production and the rated capacity of the blast furnaces with respect to the production of Pb, Zn and CNS. Scunthorpe is not operating at rated capacity and slight problems with these parameters can be contained now that they have been identified as being present.

When the possibility of treating the blast furnace wastes together with coke plant wastes was discussed, the plant expressed some reservations due to the presence not only of Pb and Zn but Ca and Na also.

The blast furnace burdens are not constant and they change both with respect to ores and blends.

Coke Plants

6-1/2"

There are three coke plants located at Scunthorpe Works, one with 5 batteries and two with 4 batteries each. Each battery consists of from 33 to 35 ovens. The total average production is approximately 1,430,000 tons per year.

Some water for coke quenching is recovered drainage from various plant areas with the balance being fresh river water. Quench water is applied at a rate of 13 m^3 (3400 U.S. gal.) per ton and is recycled. Approximately 0.5 m^3 per ton (132 U.S. gal/t) is evaporated.

The by-product plant produces crude benzol which is sent to the BSC chemicals division for further processing.

The plants operate both free and fixed ammonia stills and, with dilution, the flow to the treatment plant is in the order of 227 m^3/hr (1000 gpm). The target value for ammonia nitrogen is 115 mg/l. This value has not been attained consistently with the average over the past year being around 600 mg/l. Typical volumes of wastes flowing to the treatment plant are shown on Table IV.

A new coke plant is being constructed that will have self-contained scrubber cars for control of pushing emissions and the water will be discharged to the quench system at the plant.

The three coke plant wastes and the wastes from two tar distillation plants are treated by the biological activated sludge process. The wastes from the new coke plant will also be treated in the same biological plant. The treatment plant consists of 9 square aeration basins each 13.7 x 13.7 x 4.05 m

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TABLE IV

TYPICAL VOLUMES OF CONTAMINATED WASTEWATERS ARISING FROM COKE OVEN PLANTS

	m^3/t (US gal/t) coal carbonized	Percent
Spent ammoniacal liquor	0.24 (63.4)	53
Purge from water cooling systems	0.06 (15.8)	13
Distillates from Benzol recovery	0.04 (10.6)	9
Condensates from gas holders and mains	0.03 (7.9)	7
Miscellaneous: Plant drainage, boiler blowdown, laboratory wastes, etc.	0.08 (21.1)	18
	0.45 (118.8)	100

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(45 x 45 x 13.3 ft) deep. Twenty-four hour equalization is provided before aeration. The working depth of the basins is 3.05 m (10 ft). Each basin is equipped with a surface aerator. At a rated flow of 227 m^3/hr (1000 U.S. gpm) the retention time is 22 hours. Three clarifiers are installed each one to receive the aerated effluent from three basins. Sludge is returned to the basins that they came from so that in effect, three separate cultures are maintained.

The supernatant from the clarifiers is discharged to a tidal storage reservoir with a capacity of 3,200 m^3 (845,000 U.S. gal). Discharge from the reservoir to the River Trent occurs only during four hour periods coincident with each high tide to help achieve maximum dispersion and minimum retention of the treated wastes in the tidal reaches of the river.

The excess sludge is thickened in thickeners to approximately 3 percent solids and stored in a sludge holding tank before lagooning. The thickener supernatant is returned to the aeration tanks.

Provisions are made for the addition of acid or alkali as needed for pH adjustment in the aeration basin. Phosphate is also added to the aeration basins as additional nutrients. Operational data provided for the treatment efficiency is shown on Table V.

Although the treated wastes are analyzed at regular intervals, the plant maintains an operator on duty around the clock who routinely analyzes for CNS at frequent intervals.

The source of the coal to the coke plant varies and no correlation has been made by the plant with respect to coal and waste characteristics.

TABLE V

BIOLOGICAL TREATMENT PLANT OPERATIONAL DATA

	Raw Waste		Treated Wastes	
Parameter	Normal Avg.	General Range	Consent Value (not to exceed)	Average Quality*
pH	7.8	7.4-8.5	5-9	-
Flow (m^3/day)	5450		6800	--
SS (mg/l)	105	50-150	120	
4-hr Permanganate Value (mg/l O_2)	1900	1400-2700	120	151
BOD_5 (mg/l O_2)	1550	1200-2200	100	59
COD (mg/l O_2)	3300	2900-4500	500	411
CN (uncomplexed)	13	5-20	0.5	0.89
CNS (mg/l)	120	90-170	5	16
NH_4-N (mg/l)	115	80-200	200	470
Monohydric Phenol (as mg/l C_6H_5OH)	650	450-800	5	5
Total Phenol (as mg/l C_6H_5OH)	900	750-1200	20	18

* 1977.

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TRIP REPORT

HYDROTECHNIC CORPORATION

VISIT TO BRITISH STEEL CORPORATION ORGREAVE WORKS

Subject: Study of superior non-U.S. technology for the treatment of coke plant and blast furnace wastes.

March 28, 1979

6-1/2"

Attending

For British Steel Corp.	For Hydrotechnic
Mr. D.A. Bellamy Mr. A. Morris	Mr. H. Kohlmann Mr. H. Hofstein

For Peabody Holmes

Mr. J.D. Daniels
(plant constructor)

Orgreave Works is one coke plant comprised of two 43 oven batteries. The production is 8,700 Mg (9570 tons) of coke per week from 12,270 Mg (13,500 tons) of coal. Eighty-five percent of the coal is obtained from South Yorkshire and 15 percent from South Wales.

Coke is quenched on a once-through system at a rate of 13.6 m^3 (3,600 gallons) per quench of coke. 4.5 m^3 (1200 gallons) are evaporated and 4.5 m^3 (1200 gallons) per hour of quench water are used as diluent to the biological treatment plant. The balance of the water is discharged to the River Rother. The source of the quench water is from the barometric condenser which receives its water from the River Rother.

The by-products plant produces ammonium sulfate, crude benzol, tar and sulfur. A tar distillation plant processes the tars from the coke plant plus imported tars to produce pitches, naphthalene, anthracene, crude tar acids and a benzol absorbing oil fraction.

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A desulfurizing facility produces 99.9 percent pure liquid elemental sulfur for sale.

The gas desulfurization is done by the Holmes-Stretford process as shown on Figure O-1. The gas in contains 700 grains H_2S per 100 SCF and the gas out has less than one grain H_2S per 100 SCF. The liquor is composed of 25 g/l Na_2CO_3, 1 g/l V, 4 g/l citric acid and 2 g/l ADA (anthraquinone disulfonic acid).

Excess water from the system is removed by raising the temperature of the pumping tank to allow more water to go out with the gas. The water condenses further downstream and is bled to be treated together with the waste ammonia liquor in a biological treatment plant.

The waste ammonia liquor produced is passed through free and fixed ammonia stills and then discharged to the biological treatment plant.

A total of 54.5 m^3/hr (14,400 gal/hr) are treated in a biological treatment plant; 2/3 of the wastes are from the carbonization plant (coke and by-products) and 1/3 are from the tar plant. All wastes are discharged to a 13,636 m^3 (3.6×10^6 gallons) lagoon and from here it is pumped to two parallel treatment systems. The treatment system consists of a balance tank from where the wastes flow to an aeration tank. Both trains discharge to a common clarifier from which the sludge is discharged to a settling lagoon. Decant water from the lagoon is returned to the biological treatment plant.

The sizes and operating characteristics of the biological treatment units were not provided.

Analyses of the biological treatment plant wastes are:

	Influent	Effluent
4 hr Permanganate Value (mg/l)	1600	50
Phenol (mg/l)	300	2
CNS (mg/l)	400	trace
CN (mg/l)	10	trace
NH_4 (total) (mg/l)	120	200

The increase of ammonia is due to CNS oxidation.

The biological plant effluent presently is discharged to the river but the plant is being pressed to discharge the waste to a municipal treatment plant after the in-plant treatment.

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FLOW DIAGRAM

HOLMES STRETFORD SULFUR RECOVERY PROCESS WITH PEABODY-HOLMES FIXED SALTS RECOVERY

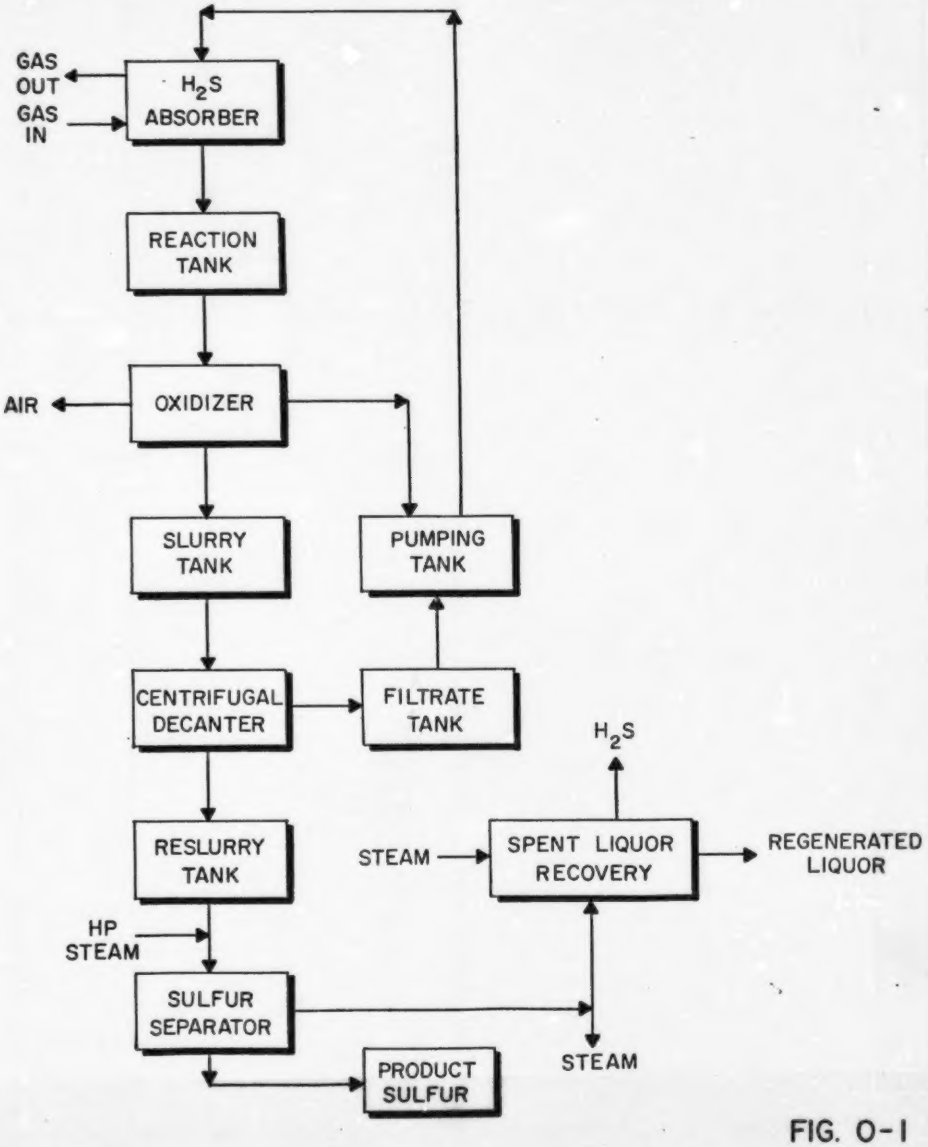
GAS OUT
GAS IN
H_2S ABSORBER
REACTION TANK
AIR
OXIDIZER
SLURRY TANK
PUMPING TANK
CENTRIFUGAL DECANTER
FILTRATE TANK
H_2S
RESLURRY TANK
STEAM
SPENT LIQUOR RECOVERY
REGENERATED LIQUOR
HP STEAM
SULFUR SEPARATOR
STEAM
PRODUCT SULFUR

FIG. O-1

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(4-76)

TRIP REPORT

HYDROTECHNIC CORPORATION

VISIT TO PONT-A-MOUSSON, FRANCE

Subject: Study of superior non-U.S. technology for the treatment of coke plant and blast furnace wastes.

March 13, 1979

Attending

For Pont-a-Mousson	For Hydrotechnic	For U.S. EPA
M. Grandpierre	Mr. H.J. Kohlman	Mr. J. Ruppersberger
M. Claudon	Mr. H. Hofstein	
M. Dannevald		
M. Bourgin	**For Degremont**	
M. Souris		
M. Marchand	M. Berne	

Blast Furnace

Pont-a-Mousson produces iron for the manufacture of iron pipe in two blast furnaces, one, No. 2, with an average production of 600 Mg /day (660 ton/day) and another, No. 3, with a production of 800 Mg /day (880 ton/day). Gas cleaning water is utilized at a rate of 470 m^3/hr (2068 gpm) in a disintegrator and discharged to a 35,000 m^3 (9,240,000 gal) lagoon. Normally the water is settled for three days and is recirculated with the exception of 40 to 100 m^3 (10,500 to 26,400 gal) per day which is discharged on a batch basis to be totally treated (cyanide, etc.)prior to discharge to receiving waters. The intermittent cyanide treatment system amounts to approximately 0.3 to 1 percent of the total flow. The blowdown limits the hardness of the circulating water to four times that of the makeup water.

The treatment consists of first adjusting pH to 9 with caustic, and then treating water with Caro's acid (H_2SO_5).

The two treatment steps take place on a batch basis in two tanks adjacent to the flue dust pond. A solution of Caro's acid at a concentration of 200 g/l is automatically added based on

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readings from a continuous analyzer until the cyanides are completely removed. This removal is controlled by Redox electrodes. Phenol is also oxidized by the Caro's acid.

The Caro's acid is stored in a tank which must be water cooled during warm weather. The cost of the acid is 1,500 French Francs per Mg (approximately $330/US Ton). NaOH costs 600 French Francs per Mg (approximately $132/US Ton).

The wastes that are recirculated back to the gas cleaning system are cooled before being used.

Once a year the flue dust ponds are cleaned by dragline. The bottom of the ponds are of consolidated clay and the sides are concrete.

During the periods when the furnaces are not operating, the CN levels in the gas cleaning water have been reported to suddenly increase from 2 mg/l to 200 mg/l. The levels that the plant has to keep to in the effluent are 0.2 mg/l of CN and 0.5 mg/l of phenol. When the capacities of the furnaces are suddenly modified (changing of the charge, additional coke split, etc.), the temperature increases as well as the CN concentration.

The plant personnel have stated that their incentives for the extensive recirculation system are, first, their regard for ecology, and second, to avoid conflicts with the regulatory authorities.

The cooling system of the blast furnace operates at a recirculation rate of 60 percent. This water is not polluted. The water application rate for both furnaces is 1,800 m^3/hr (7920 gpm) with a blowdown and makeup of 720 m^3/hr (3170 gpm) (40 percent).

Analyses of the blast furnace water systems are as follows:

	Q m^3/hr (gpm)	pH	SS mg/l	CN mg/l	Phenol mg/l	TDS mg/l	NH_3 mg/l
Discharge from gas cleaning to settling	470 (2070) Avg. over 1 day	7.7	1500	1.5	3.0	2400	0-100
Discharge from settling to further treatment (CN removal)	2 (9)	7.6	20	0.5	2.5	2300	
Discharge from CN removal to river	2 (9)	8.6	0	0.1	0.5		
Discharge from settling to gas cleaning (recycle)	470 (2070)	7.6	20			2300	
Makeup water	2 (9)	7.5	15			1000	
Furnace cooling water applied	1800 (7920)	7.5	15			1000	
Cooling water blowdown	720 (3170)	7.5	15			1000	
Cooling system makeup	720 (3170)	7.5	15			1000	

Coke Plant

The Pont-a-Mousson plant presently has four small batteries with a total of 113 ovens and a total capacity of 700 Mg /day (770 ton/day). In the first stage of the plant modification, two of the batteries will be taken out of service and a new modern one will be built. In a second stage, the remaining two old batteries will be shut down and replaced by a second one. The description that follows is based on the projected operations of the two battery coke plant.

The two batteries will each have 24 ovens and total coke production will be from 800 to 900 Mg /day (880 to 990 ton/day).

Coke will be quenched with river water and quench water consumed at a rate of 0.6 m^3/ Mg (114 gal/ton), all of which will be vaporized. The system will be a steam pressure quenching operation.

A pushing dust control system will be installed. The process is a German one (ERIN) that has been installed at BOCHUM in the Ruhr. The American license for the system is Interlake Steel.

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During a push, the car is covered and the solids-laden air and gases exhausted to a Thysson scrubber. These gases will be scrubbed with water at a rate of 2.7 m^3/hr (12 gpm). After settling, the water will be used as makeup to the coke quench system. This water is approximately eight percent of the quench water.

The dust recovered, i.e. 8 kg/15 Mg of coke from ERIN process, 10 kg/ Mg of dust of coke quenched, will be recycled to be charged in the ovens.

The by-products produced at the coal chemicals plant are benzol, tars and ammonium sulfate which are sold.

The stripped WAL will be first discharged to a sulfuric acid neurtalization tank from where it will be pumped to another tank at which $FeSO_4$ will be added. The WAL will then overflow to an aeration tank where phosphoric acid (H_3PO_4) will be added.

Finally, the discharge from the aeration tank will be sent to a clarifier and then to an aerated lagoon for discharge to the Moselle River.

Sludge from the clarifier will be recycled to the influent of the aeration tank. Provisions will be made for the addition of 13 to 20 m^3/hr (57 to 88 gpm) dilution water to the head of the aeration tank.

Design details of the treatment system (i.e. detention time, chemical dosage, overflow rates, etc.) were not available.

The anticipated qualities of the water provided are as follows:

	Q m^3/hr (gpm)	pH	SS mg/l	CN mg/l	NH_3 mg/l	S mg/l	Phenol mg/l	O&G mg/l
WAL from by-products plant	7 (30)	8.8-9.2	1400	40-50	6500-8800	100	2700	2600
WAL from stills to biological treatment	8 (35)	6.8-8.5	32	22	200-400		2200	
Dilution water	13-20 (57-88)	7.6-8						
Treated effluent	24 (106)	6.5-8.5	30		200/400		0.2	20 (hydro carbon

Approximately 200 kg (440 lbs) per day of solids produced will be incinerated.

TRIP REPORT

HYDROTECHNIC CORPORATION

VISIT TO ITALSIDER S.p.A., TARANTO WORKS

Subject: Study of superior non-U.S. technology for the treatment of coke plant and blast furnace wastes.

March 5, 1979

Attending

For Italsider	For Hydrotechnic
Dott. Ing. A. Mariani	Mr. H. Kohlmann
Mr. E. Di Leo	Mr. H. Hofstein

Coke Plant

The coke plant consists of ten batteries of 43 ovens each with a capacity of 5 x 10^6 Mg (5.5 x 10^6 tons) per year. The by-products plant produces ammonium sulfate $(NH_4)_2SO_4$, impure benzol, and naphthalene. Tars produced are partially burned in the power house and the balance is sold. Gas collected from batteries 1 through 6 is treated with sulfuric acid (H_2SO_4) to make the ammonium sulfate; the gas from batteries 7 to 10 is washed by excess ammonia liquor produced by all batteries.

All of the waste ammonia liquor is passed through two free ammonia stills operating in parallel. The ammonia and hydrogen sulfide (NH_3 and H_2S) stripped from the waste stream is incinerated and discharged through a 125 m (400 ft) coke plant stack.

The stripped waste from the stills is discharged to an activated sludge biological treatment plant. The activated sludge plant consists of three parallel aeration basins, three clarifiers and three thickeners sized for a design flow of 850 m^3/hr (3740 gpm). However, due to operational problems at the by-products plant caused by corrosion, the final cooler water contains hydrocarbons that are toxic to the biological

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treatment plant. No problems due to tars have been experienced at the biological plant due to the dry electrostatic precipitators used for the gases. At the design flow of 850 m^3/hr (3740 gpm), the detention time in the three basins is estimated to be 24 hours.

Approximately once a year, due to maintenance at the ammonia stills, the waste ammonia liquor by-passes the still and is discharged directly to the biological plant. At that time a volume of fresh water equal to the volume of wastewater is added for dilution.

Phosphoric acid (H_3PO_4) is normally added to the waste flow at a rate of 8 liters of 98 percent acid per day for nutrient requirements. This dosage rate is increased when the pH in the basins rises above 8.2.

The sludge from the thickeners is dewatered by vacuum filters to approximately 50 percent solids and approximately 75 m^3/day (19,800 gal/day) is disposed of on land fills.

Operational Analyses

	Raw Waste	In System	Discharge
pH	8.7	7.9	7.8
SS	-	3100	22
CN (tot)	98	-	1.2
NH_3 (tot)	1010	-	1010
Sulfur	0	-	0
Phenol	510	-	2.0
Permanganate	1380	-	68

All values, except pH, in mg/l.

The treated flow from the biological treatment plant flows to the main plant sewer which discharges a total of 70,000 m^3/hr (440 gpm) to the Gulf of Taranto.

Fresh water is used as makeup to the quench systems and is recycled to extinction. Volumes of waste applied or made up were not available.

Blast Furnaces

The plant operates five blast furnaces. Nos. 1-4 have rated capacities of 4,000 Mg/day (4400 tons/day) each and No. 5 has a rated capacity of 10,000 Mg/day (11,000 tons/day).

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Non-contact cooling water at blast furnaces 1-4 is on a once-through basis using salt water. Blast furnace 5 uses fresh water which is cooled and recirculated. For the hearth cooling water, Polynodic 621 is added to prevent corrosion. At blast furnace 5 the cooling water is applied at a rate of 6,800 m^3/hr (29,900 gpm). Blowdown flow and applied water rates were not given for blast furnaces 1-4.

Fresh water is used in the gas washer at blast furnaces 1-4 which is settled and recirculated. Although there are provisions for cooling the cooling systems were abandoned. Blast furnace No. 5 uses fresh water which is settled and recirculated after cooling.

Gas washer water is directed to the settling facilities from two sources: the gas scrubbers which discharge acidic water and the dust cleaning systems at the stock houses which discharges basic water. The water is recirculated to both facilities and the chemical additions are Betz 1120 floc aid added before the thickeners and Betz 413 added to the recirculated water to avoid corrosion.

Water Uses

Blast Furnace No.	Application Rate (m^3/hr (gpm))	Blowdown (m^3/hr (gpm))
1	1500 (6600))	250 (1100)
2	800 (3520))	
3	800 (3520))	
4	2000 (8800)	80 (352)
5	2500 (11,000)	150 (660)

The only analysis available at the blast furnaces was the following blowdown quality:

CN (total)	2-3 mg/l
SS	30 mg/l
Phenol	Negligible

The sludge goes to the stockyard and ultimately ends up in the sinter plant. No problems with zinc or lead were indicated.

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Other Data

1. By 1985 the plant must meet the following discharge requirements:

Parameter	Concentration
pH	5.5-9.5
H_2S	1 mg/l
Fe (tot)	2 mg/l
Cr^{+6}	0.2 mg/l
SS (greater than 0.5 um)	80 mg/l
CN (tot)	0.5 mg/l
oil	5 mg/l
Mn	2 mg/l
BOD_5	40 mg/l
T	3C° at 1 km from discharge (Maximum T = 35°C for sea discharges)
NH_4	15 mg/l
Total Phenol	0.5 mg/l
Cr^{+3}	2 mg/l
COD	160 mg/l

Until 1985 the limitations with the exceptions of pH and temperature, are twice the above.

2. Air discharge requirements beyond 1.5 m (5 ft) from the plant boundary (all parameters in mg/m^3 at 1013 mbar and 25°C).

Parameter	24-hour	
Parameter	Average	Maximum
Dust	0.3	0.75 (2 hours)
$SO_2 + SO_3$ as SO_2	0.39	0.79 (0.5 hour)
$NO + NO_2$ as NO_2	0.19	0.56 (0.5 hour)
H_2S	0.04	0.10 (0.5 hour)
CO	23	57 (0.5 hour)
SiO_2 (crystalline)	0.02	0.10 (2 hours)

3. BOF No. 1 solids go to the stockyard.
BOF No. 2 solids go to the sinter plant.
Zinc is stated to be strictly controlled so that no problems are encountered. The method of control was not given.

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TRIP REPORT

HYDROTECHNIC CORPORATION

VISIT TO KOBE STEEL, LTD.

CORPORATE OFFICES, KOBE, JAPAN

KAKOGAWA WORKS, KAKOGAWA, JAPAN

Subject: Study of superior non-U.S. technology for the treat-treatment of coke plant and blast furnace wastes.

May 16, 1979

Attending

For Kobe Steel	For the Kansai Coke and Chemical Co.	For Shinko-Pfaudler Co., Ltd.
Mr. T. Morimura		
Mr. R. Yagyu	Mr. I. Yamamoto	Dr. K. Sono
Mr. K. Okubo	Mr. K. Nakagawa	Mr. K. Nagase
Mr. T. Ideguchi		
Mr. T. Kawachi		
Mr. M. Mitamura		

For Hydrotechnic

Mr. H. Hofstein
Mr. J. Chu

Coke Plant

Coke for blast furnace use at Kobe Steel, Ltd., Kakogawa Works is produced at the plant site at a two battery coke plant built and operated by The Kansai Coke and Chemicals Co., Ltd.

One of the two batteries has 120 ovens and the other has 128 ovens. The average coke production is 7500 Mg/day (8250 tons/day). By-products produced from the coke oven gas are tar, BTX, ammonium sulfate, sulfuric acid and calcium sulfate.

Air pollution control facilities are installed at the coke ovens to control both charging and pushing emissions. Scrubber cars are used for charging. Pushing emissions are controlled by the use of wet scrubbers and wet electrostatic precipitators. It was reported that all water is recycled and that there is no blowdown from the system.

Approximately 2.6 m^3 (686 gal.) of water is required to quench one Mg of coke. Each coke oven push is 22-23 Mg of coke and during the quench approximately 10 m^3 (2640 gal.) are evaporated. The remaining quench water is recycled and makeup to the system is fresh industrial water drawn from the Kakogawa River. The coke oven gas is desulfurized in a proprietory process that utilizes a wet scrubber. Ammonia is extracted from the coke oven gas. The primary coolers are indirect and the secondary coolers are direct and the cooling water use for the direct cooler is recycled.

Approximately from 1500 to 1800 m^3 per day (278 to 330 gpm) of excess waste ammonia liquor is discharged to a 24-hour retention basin with dilution water prior to treatment. The volume of dilution water is assumed to be equal to the volume of waste ammonia liquor. The diluted waste is discharged to an activated sludge treatment plant which consists of six 14 m x 14 m (46 ft x 46 ft) aeration basins, two with covers. These aeration basins are equipped with surface aerators, three of which operate at any one time. Their depth is 4.5 m (15 ft). The wastes are discharged to a rectangular settling basin equipped with a scraper mechanism. A portion of the sludge is dewatered in a "Dual Cell Concentrator" and the balance is recycled to the activated sludge aeration basins. The water from the concentrator is returned to the aeration basin and the dewatered solids are incinerated. The supernatant from the settling basin is filtered in a pressure sand filter operating at the rate of 15 $m^3/m^2/hr$ (6 gpm/ft^2) and the filtered waste is discharged to the Inland Sea.

Sulfuric acid (H_2SO_4) and phosphoric acid (H_3PO_4) are added to the influent to the aeration basin respectively for pH control and the biological system nutrient requirements. The dosage of the H_3PO_4 is at a rate of 0.6 mg per 100 mg/l of BOD_5 but methods of feed control were not provided.

Analyses provided were:

	pH	SS	Cl	Free CN	CNS	Phenol	$KMnO_4$
Makeup Water (River)	7	10-20	15	-	-	-	-
Treated Discharge	-	-	-	0	0	1	100-200

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Analyses for ammonia were not available.

Analyses of the excess ammonia liquor either before or after dilution was requested but were not available.

The total water used for wet scrubbers and wet electrostatic precipitators at the coke plant is 17,000 m^3/day,(4.5 mgd), and the water is recycled.

Blast Furnaces

Kakogawa Works has three blast furnaces operating, one with a volume of 3,090 m^3 (109,100 ft^3), the second witn a volume of 3,850 m^3 (136,000 ft^3) and the third with a volume of 4,500 m^3 (159,000 ft^3). Usually two blast furnaces operate while the other is revamped.

Furnace cooling water is recirculated and the blowdown of 500 m^3/day (2200 gpm) is used as makeup to each of the blast furnace gas cleaning systems.

Each of the blast furnaces uses a venturi scrubber and two wet electrostatic precipitators to clean the gas after the dry dust catcher. The venturis require 800 m^3/hr (3520 gpm) each and the two electrostatic precipitators at each furnace require 300 m^3/hr (1320 gpm). The solids laden water is discharged to thickeners at each furnace. One thickener is 45 meters (148 ft) diameter and the other two are 50 meters (164 ft) diameter. Most of the water discharged from the thickeners is cooled and recycled. Polyelectrolytes are added to the thickener influents to enhance solids settling and sodium hydroxide is added for pH control. 500 m^3/day (2200 gpm) are blown down from each recirculation system and is used for slag quenching. The water applied to the slag evaporates and there are no discharges to public waters from the gas cleaning system.

The solids from the thickener are sent to the pelletizing plant to be used as an iron source with the ore.

Analyses provided are:

	pH	SS
Discharge to Thickeners	-	2000
Discharge from Thickeners	7.5	50

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TRIP REPORT

HYDROTECHNIC CORPORATION

VISIT TO SUMITOMO METAL INDUSTRIES, LTD.

KASHIMA STEEL WORKS

Subject: Study of superior non-U.S. technology for the treatment of coke plant and blast furnace wastes.

May 22, 1979

6-1/2"

Attending

For Sumitomo Metal Ind., Ltd.	For Hydrotechnic
Mr. T. Nagasawa	Mr. H. Hofstein
Mr. T. Kodama	Mr. J. Chu
Mr. H. Toyozawa	
Mr. H. Ikeuchi	

Blast Furnaces

Kashima Works has three blast furnaces, two of which presently operate at any one time. The average production is 8000 Mg /day (8800 tons/day) each. The furnace gases at all three of the blast furnaces are cleaned by wet methods following dry dust catchers. One furnace uses a ring slit washer and the other two use venturi scrubbers followed by wet electrostatic precipitators. Each system uses approximately 1000 m^3/hr (4400 gpm) of water. The solids laden water at each blast furnace is discharged to a clarifier and the settled water is recycled without cooling. Polyelectrolyte is added to enhance solids settling. Blowdown from each system is approximately 150 m^3/hr (660 gpm) which is used as makeup water at the slag quenching facilities. The water at the slag pits is recirculated at a rate of approximately 600 m^3/hr (2640 gpm). No discharges from the gas cleaning or slag quenching systems to public waters are reported, but there are some discharges during unbalanced conditions.

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The sludge from the clarifiers is discharged at a rate of 25 Mg/hr (27.5 tons/hr) to the pelletizing plant at 20 percent solids. Therefore, the total water blowdown from each system is approximately 170 m^3/hr (748 gpm). No analyses of any of the blast furnace system waters were provided.

Coke Plant

Kashima Works operates seven coke oven batteries with a total of 292 ovens that produce a total of 7000 Mg (7700 tons) of blast furnace coke per day. Two by-product plants are in operation.

The coke oven gas is desulfurized by the "FUMAKS" method that produces elemental sulfur for sale. After desulfurization the gas is further washed where ammonia and cyanide as thiocyanate and ammonium cyanide is removed and the wash water is passed through a separate free ammonia still separate from the ammonia liquor still.

Excess ammonia liquor is discharged to a tar decanter and then to free and fixed ammonia stills. Lime or caustic is used in the fixed still. The stripped ammonia from both stills is burned in an incinerator. Stripped wastes are discharged into an equalization basin where industrial fresh water is added for dilution. The diluted wastes are treated in a parallel two cell activated sludge plant with settling. The treated wastes are then discharged to the Pacific Ocean with other wastewater and a large quantity of cooling water.

Approximate analyses (in mg/l) provided were:

	SS	CN	Phenol	COD
Influent to Treatment	10	20-25	1500	2000-4000 (not including phenol)
Effluent from Treatment	40	2	Trace	250

Coke quenching is on a recycle system with fresh water used as makeup.

Volumes of water used, water application rates, volumes of wastes produced or treated, dilution water volumes or volumes discharged to the ocean were not provided.

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TRIP REPORT

HYDROTECHNIC CORPORATION

VISIT TO KAWASAKI STEEL CORP.

CHIBA WORKS, CHIBA, JAPAN

Subject: Study of superior non-U.S. technology for the treatment of coke plant and blast furnace wastes.

May 23, 1979

Attending

For Chiba Works	For Hydrotechnic
Mr. T. Tanaka	Mr. H. Hofstein
Mr. K. Tsutsumi	Mr. J. Chu
Mr. H. Takao	
Mr. S. Hirai	

Blast Furnaces

Chiba Works has five operable balst furnaces of which three were operating at the time of the visit. One furnace has a capacity of 2500 Mg /day (2750 tons/day), two have capacities of 3500 Mg /day (13,850 tons/day), one has a capacity of 5200 Mg /day (5720 tons/day) and the newest blast furnace, No. 6, has a capacity of 10,000 Mg /day.

The water system described herein is that for the newest and largest furnace. Blast furnace gas is cleaned in a venturi scrubber, using approximately 1600 m^3/hr (7040 gpm). Scrubber effluent discharges to an inlet pit from which it flows to two parallel aeration basins. The wastewater is aerated for appromitaly 12 minutes to strip carbon dioxide and control pH. The system is the German "ATH system". Flow from the aeration basins is to a splitter box which discharges to one of two thickeners. One thickener is used as a standby. Each thickener is 26 m (85 ft) diameter by 5.5 m (18 ft) deep. Polyelectrolyte is added at the thickener influent and the

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thickener overflow is to a treated water pit. From the treated water pit the water is pumped to a cooling tower and then returned to the venturi scrubber for reuse. Makeup at the rate of 80 m^3/hr (350 gpm) is from blast furnace cooling and from a lake. Blowdown at a rate of 10 m^3/hr (44 gpm) is used for slag cooling. Sludge from the thickener is pumped to a distant thickener which also receives sludge from other blast furnace gas cleaning systems. The second thickener underflow is dewatered in a tube press and the solids are sent to the pelletizing plant. Filtrate from the tube press is sent to slag cooling. Approximately 30 m^3/hr (130 gpm) of filtrate and 70 m^3/hr (308 gpm) from the BOF gas cleaning system and the sinter plant is used for slag cooling.

Analyses of the furnace gas cleaning system water provided were:

	Gas Cleaning Water to Treatment	Treated Gas Cleaning Water
Fe (mg/l)	23	0
pH	7	8.1
SS (mg/l)	1470	9
TDS (mg/l)	5532	4526
SO_4 (mg/l)	423	433
Cl (mg/l)	2387	2337
Total Hard. (mg/l) as $CaCO_3$	680	556
Ca Hard. (mg/l) as $CaCO_3$	391	319
M Alk. (mg/l) as $CaCO_3$	298	319
Turbidity (JTU)	105	2
Conductivity (us/m^2)	8630	8205

Coke Plant

Chiba Works has ten coke oven batteries with a total of 402 ovens with a total capacity of 8070 Mg/day (8880 tons/day). The batteries are operated by the Kawatetsu Chemical Industry Co. and the by-products plant produces plant produces tar, benzol, and naphthalene. Tar is used on the roads in the plant.

Charging and pushing emissions are controlled by a common scrubbing system at each battery. The scrubber water is settled

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and recirculated and blowdown is to the coke quenching breeze pit. Data was not available as to how much water is required at each operation nor how much is blown down to the breeze pit.

Quenching at all batteries utilizes 350 m^3/hr (1540 gpm) of recirculated water. Makeup to the system is well water from product indirect cooling systems. Primary and secondary indirect gas coolers use salt water on a once-through basis.

The coke oven gas is desulfurized by limestone scrubbing and calcium sulfate is produced as a by-product.

Approximately 2300 m^3/day of excess ammonia liquor is stripped of ammonia by steam in a free ammonia still. The ammonia is returned to the coke oven gas and the stripped liquor passes through a coke filter for removal of tars. The wastewater is then discharged to a pre-aeration tank where sulfuric acid and air are added for pH control and mixing. The detention time is a few minutes after which the wastes are discharged to three aeration basins with a detention time of 33 hours, where air and phosphoric acid are added. Approximately 2300 m^3/day (422 gpm) of sea water is added for dilution. The temperature is maintained at from 24 to 34^{o}C, the dissolved oxygen - 1-3 mg/l and the pH - between 7.0 and 7.2.

The aerated wastes are discharged to a clarifier with a detention time of 6 hours. Ferric chloride is added to the clarifier influent at a rate of 100 mg/l. Sludge is returned to the aeration basin influent to maintain a MLSS load of from 5000 to 6000 mg/l and excess sludge is dewatered and sent to the coke ovens for disposal. The settled wastes from the clarifier are discharged to a sedimentation basin with a detention time of 4.4 hours and a surface loading rate of 22 m^3/m^2/day (0.4 gpm/ft^2). The influent to the sedimentation basin is dosed with 100 mg/l ferric chloride, 50 mg/l hydrated lime and 0.2 mg/l polyelectrolyte and the effluent suspended solids are below 50 mg/l.

The wastewater is pumped from the sedimentation basin to a pressure retaining granular media filter. The filtration rate is 15.9 m^3/m^2/hr (6.4 gpm/ft^2) with a resulting suspended solids concentration of less than 10 mg/l. Filter backwash is discharged to the sedimentation basin and sludge from the sedimentation basin is dewatered with sludge from the clarifier.

The filtered waste is passed through an activated carbon bed at a rate of 13.2 m^3/m^2/hr (5.3 gpm/ft^2 prior to discharge to Tokyo Bay.

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Analyses provided are:

	Q m^3/day	pH	Phenol mg/l	COD $KMnO_4$ Value mg/l
Treatment Plant Influent	2300	9	200-300	3000/4000
Treatment Plant Effluent	4600	7	< 0.02	50

TRIP REPORT

HYDROTECHNIC CORPORATION

VISIT TO NIPPON KOKAN K.K., TOKYO

Subject: Study of superior non-U.S. technology for the treatment of coke plant and blast furnace wastes.

May 21, 1979

Attending

For Nippon Kokan (NKK)	For Hydrotechnic
Mr. H. Tsubaki	Mr. H. Hofstein
Mr. R. Suwa	Mr. J. Chu
Mr. T. Koizumi	
Mr. M. Kameoka	

Nippon Kokan (NKK) operates two integrated steel plants, Fukuyama Works located on the Inland Sea near Hiroshima and Keihin Works located on Tokyo Bay near Yokahama. Keihin Works is constructed on the man made island of Ogishima. This report consists of the description of the wastewater facilities for the coke plant and blast furnaces at Ogishima. Since a plant visit was not permitted the report which follows contains descriptions provided at the offices of NKK in Tokyo.

Blast Furnace

Ogishima has one blast furnace in operation with a second scheduled to startup in July 1979. Each furnace has a capacity of 8000 Mg/day (8800 tons/day). The blast furnace gas goes through a dry dust catcher, a venturi scrubber, a mist separator and an electrostatic precipitator. Water, at the rate of 3 to 4 m^3/ Mg (720-960 gal/ton) of iron, is applied at the venturi scrubber and water at the rate of 3000 to 4000 m^3/day (790,000 to 1,050,000 gal/day) is applied at the electrostatic precipitator. The solids laden water from the venturi scrubber, mist separator and the electrostatic precipitator flows to a flow control pond and then to a settling tank.

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From the settling tank the water flows to a thickener for additional solids removal. The thickener overflows to a second flow control pond from which it is pumped to a cooling tower and then recirculated back to the venturi scrubber. The electrostatic precipitator utilizes water blown down from the indirect blast furnace cooling system. From 2000-3000 m^3/day (528,000 to 792,000 gpd) is blown down from the gas cleaning system cooling tower and used for slag cooling in the slag pit and dust suppression in the ore yard.

Sludges from the settling tank and the thickener are sent to the sintering plant. Although there are no problems with zinc in the flue dust now, these problems are expected by the time the second blast furnace goes on line. At that time NKK expects to study dezincing plants.

Sizes of equipment, operating parameters and qualities of water were not provided.

Coke Plant

Ogishima has one battery of 124 ovens operating and a second battery of 74 ovens scheduled to start operation in July 1979. Each oven receives a coal charge of 38 Mg (42 tons) of coal and the annual production of the operating battery is 2.1×10^6 Mg (2.31×10^6 tons) of coke. Dry coke quenching is used. The operating battery has five vessels, four of which normally operate and the new battery will have three vessels where steam is generated at 15 kg/hr (225 psi) in separate boilers at each vessel at a rate of 40 kg/hr (88 lbs/hr) for use throughout the plant.

Battery No. 1 desulfurizes the coke oven gas by the "Takahax process" and Battery No. 2 will be equipped with the "Sulfiban process".

Ammonia, tars and crude oil are generated from the coke oven gas. The tars are injected into the blast furnace, the crude oil is sold and the ammonia is sent to the NKK fertilizer division located off the plant site. Waste ammonia liquor is produced at a rate of 0.15 to 0.2 m^3 per Mg (30 to 88 gal/ton) of coal charged. The waste ammonia liquor is passed through free and fixed ammonia stills. Plant No. 1 uses caustic in the fixed still and Plant No. 2 will use lime. One treatment plant will be used to treat the wastes from both batteries. From 1200 to 1300 m^3/day (220 to 240 gpm) is discharged to an equalization tank with a two day retention time then pumped to the aeration tank of an activated sludge biological treatment plant. Sulfuric acid is added for pH control and phosphoric acid for nutrient requirements. The aeration time is from one to two days.

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The aeration tank discharges into a thickener which in turn overflows to a coagulating-sedimentation tank. A portion of the thickener sludge underflow is recycled to the head of the aeration tank and the balance dewatered and incinerated. Ferric chloride and polyelectrolytes are added to the coagulating-sedimentation tank. The sludge is dewatered with the thickener sludge and incinerated. Settled wastes from the coagulation-sedimentation tank overflows to a buffer tank and then to a gravity sand filter. The filter backwash is discharged to the head end of the aeration tank. Filtrate is pumped through an activated carbon column which discharges to a terminal pond. The pond overflows to Tokyo Bay and a portion is used as filter backwash water.

The activated carbon is used so that the plant can meet the COD discharge regulations. Local regulations, established by the prefecture of Kanagawa, call for a COD limit of 25 mg/l.

The only quality data provided was that the plant meets discharge regulations. The quality of the wastes into the ammonia stills or the quality into the treatment plant could not be divulged by the corporation personnel.

Charging emissions are controlled by evacuating approximately 1000 m^3/min (35,000 ft^3/min) of air to a venturi scrubber where it is scrubbed with approximately 100 m^3/hr (26,400 gal/hr) of water.

Pushing emissions are controlled by covering the coke car and evacuating 3000 m^3/min (105,000 ft^3/min). The air is cleaned in a venturi scrubber and a wet electrostatic precipitator which, combined, use approximately 280 m^3/hr (1230 gpm) of water.

The water from both systems is settled in a settling tank and recirculated. Approximately 1200 m^3/day (22 gpm) is blown down to Tokyo Bay. The sludge is dewatered and sent to the sintering plant. The sizes of the facilities and water qualities were not provided.

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TRIP REPORT

HYDROTECHNIC CORPORATION

VISIT TO ALTOS HORNOS DE MEXICO, S.A.

MONCLOVA, COAH., MEXICO

Subject: Study of superior non-U.S. technology for the treatment of coke plant and blast furnace wastes

October 9, 1979

6-1/2"

Attending

For Altos Hornos	For Hydrotechnic
Ing. Jose Luis Velasco P.	Mr. H.J. Kohlmann
Ing. Jorge Castro	Mr. H. Hofstein
Mr. Velasquez	
Ing. Raul Montelongo R.	**For U.S. EPA**
	Mr. J. Ruppersberger

Blast Furnaces

Altos Hornos De Mexico operates four blast furnaces. Their capacities are:

No. 1 - 600 Mg per day (660 tons per day)
2 - 1000 Mg per day (1100 tons per day)
3 - 1200 Mg per day (1320 tons per day)
4 - 1500 Mg per day (1650 tons per day)

Blast furnaces 1 and 2 use gas washers followed by a wet electrostatic precipitator for gas cooling and cleaning; blast furnace 3 gases are cleaned with an orifice plate scrubber and blast furnace 4 uses a venturi for gas cleaning. The total quantity of water used for gas cleaning at blast furnaces 1, 2 and 3 is 1021 m^3/hr (4500 gpm) and No. 4 uses 450 m^3/hr (1980 gpm).

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The gas cleaning water from blast furnaces 1, 2 and 3 is discharged to a splitter box and distributed to three 70-foot diameter clarifiers. A dispersant is added to the clarifier discharges at a rate of 5 mg/l and the water is cooled and recycled back to the gas cleaning systems. Sludge from the three clarifiers is withdrawn once per turn (8 hours at a rate of 22 m^3/hr (97 gpm) (total) until the discharge appears clean. The total volume of sludge withdrawn per turn was not available.

The gas cleaning water from blast furnace 4 is discharged to a 16.8 m (55 foot) diameter clarifier. Effluent from the clarifier is cooled and approximately 410 m^3/hr (1800 gpm) is recycled back to the cleaning system. Sludge is constantly withdrawn at a rate of 40 m^3/hr (176 gpm). The water in the sludge withdrawn from the clarifiers acts as the total blowdown of the blast furnace gas cleaning system.

The sludge is discharged to two lagoons, operated in series, having a total volume of 22,000 m^3 (5.8×10^6 gallons). Blast furnace cooling water blowdown, water treatment plant sludge, power plant demineralizer regenerants and treated municipal sewage also discharge to the lagoons.

The effluent from the second lagoon is discharged, at a rate of from 0 to 108 m^3/hr (0 to 475 gpm) to the river and 136 to 270 m^3/hr (600 to 1190 gpm) is used as industrial water makeup for coke quenching, slag quenching, BOF gas cleaning and blast furnace gas cleaning.

Coke Plant

Four coke oven batteries (2 with 57 ovens each, one with 69 ovens, and one with 35 ovens) are in operation at Altos Hornos, producing 2100 Mg/day (2300 tons/day) of metallurgical quality coke. By-products produced are tars, BTX, naphthalene and ammonium sulfate.

Approximately 300 m^3/day (79,200 gal/day) of excess ammonia liquor is passed through a free ammonia still prior to use for quenching coke. The balance of the 72 m^3/hr (317 gpm) required for coke quenching water is drawn from the blast furnace lagoon system described above, from the coke plant cooling tower blowdown, and from reverse osmosis reject streams. The quench water is recirculated with no blowdown since all water evaporates. No treatment is provided for any other wastewater arising at the coke plant.

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Other Observations

The total plant water use for all processes up to and including plating is 6.8 m^3/Mg (1975 gal/ton). Makeup water to the plant is softened and higher quality water requirements are satisfied by processing water through reverse osmosis units. The raw water has 1500 mg/l total dissolved solids which is reduced to 600-700 mg/l by reverse osmosis. One module processes 90 m^3/hr (396 gpm) with a 50 percent reject stream and 6 other modules each process 36 m^3/hr (158 gpm) with reject streams of 33 percent. The reject streams are mixed with other wastes and used for quenching.

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TRIP REPORT

HYDROTECHNIC CORPORATION

VISIT TO HOOGOVENS IJMUIDEN BV, IJMUIDEN HOLLAND

Subject: Study of superior non-U.S. technology for the treatment of coke plant and blast furnace wastes.

March 14, 1979

Attending

For Hoogovens	For Hydrotechnic	For U.S. EPA
Ir. B. K. Heller Dr. Ir. C. P. Heijwegen Ir. P. A. Van Zijll Langhout	H. J. Kohlmann H. Hofstein	J.Ruppersberger

Coke Plant

Hoogovens operates two separate coke plants: KF-1 with seven batteries (4 of 36 ovens each, 2 of 30 ovens each and one of 27 ovens) and KF-2 with 4 batteries of 27 ovens each. KF-1 with seven batteries produces 3000 (3300 tons) of coke per day and KF-2 with 4 batteries produces 3500 Mg (3850 tons) of coke per day.

Both coke plants require 2.5 m^3 (660 gallons) of water per Mg of coke for quenching. Fresh water from the Rhine River is used and is recycled. The only time there is a discharge from the quench system is when the quench basin has to be cleaned. The basin is then dewatered by discharging all of the standing water to the sewer that leads to the harbor.

The by-products plant at KF-1 produces tars, $(NH_4)_2 SO_4$, and 78 percent H_2SO_4. At KF-2 tars and 96 percent H_2SO_4 are produced.

The gases at KF-1 and KF-2 are desulfurized to produce the sulfuric acid.

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KF-2 discharges 25 m^3/hr (110 gpm) WAL and 20 m^3/hr (88 gpm) of gas purification water. KF-1 discharges 15 m^3/hr (66 gpm) waste ammonia liquor (WAL) to a free ammonia still.

70 m^3/hr (308 gpm) of wastes are discharged from the ammonia still to a mixing basin where HCl waste pickle liquor is added together with 5 kg/d of 100 percent NaOH, 3L/hr of 100 percent H_3PO_4 and a deformer. The actual doses of H_3PO_4 and waste pickle liquor is based on flow and NaOH is based on pH in the aeration basin.

The mixing tank discharges to a 1500 m^3 (396,000 gals.) aeration basin equipped with four surface aerators. The aeration basin was originally designed for a flow of 150 m^3/hr (660 gpm) and a detention time of 10 hours. However, under the present flow conditions, the retention time is 21.4 hours.

The aeration basin discharges to a 200 m^2 (2150 gpm) settling tank where waste pickle liquor is added. Sludge is recycled to the head end of the aeration basin and excess sludge is discharged to the sewer with the settling tank supernatant.

Biological treatment plant parameters desired are 3000 mg/l MLSS, temperature 30-35°C, pH 7-8. The optimum temperature is 25-35°C. When the temperature rises above 37°C the treatment efficiency drops off. Above 45°C the efficiency of phenol degradation is approximately 60 percent.

The plant plans to place a dissolved oxygen probe in the aeration basin and try to maintain a dissolved oxygen concentration of 0.5-1 mg/l. Dissolved oxygen changes in the biological system are indicative of upsets in the by-products plant. During periods of serious upsets the wastes bypass the biological plant.

There is no dilution water added to the system but the plant plans to install a recirculation system to return a portion (approximately 40 m^3/hr)(176 gpm) of the effluent back to the head end of the plant.

The quantities and qualities of the waters at the coke plant are as follows:

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	Q m^3/hr (gpm)	pH	CN mg/l	NH_3 mg/l	S mg/l	Phenol mg/l	Cl mg/l	SO_4 mg/l	HCO_3 mg/l	NO2 mg/l	COD mg/l
KF-1 WAL	15(66)	-	-	6000	500	-	6000	0	-	-	-
KF-2 WAL	25(110)	-	-	6000	500	-	5000	0	-	-	-
Gas purification water	20(88)	-	-	5000	-	-	200	100	-	-	-
Ammonia still effluent	70(308)	5.5	1-10	1000-1800*	5-10	400-700	3000	-	-	-	2000-3000
Biological Treatment Plant Effluent	70(308)	7-8	1	1000-1800*	5	35**	3000	-	0	0.02	900-1000

* Fixed ammonia
** When working very well phenol is 5 mg/l

Other Coke Plant Information

When the sulfuric acid plant is not operating the sulfur bearing gas will be dissolved in water and stored in a 1500 m^3 (396,000 gallon) tank (2-3 week supply). When the plant goes back on line the dissolved gas will be put through the strippers again to remove them from the water.

When free ammonia enters the system the dissolved oxygen rises due to the killing of the organisms in the system. If the electrostatic precipitator is not operating properly, the presence of tars in the biological system causes upsets. There is no equalization before the biological system although the plant personnel feel that this feature would be helpful.

Coke ovens are controlled so that the push cannot take place until the coal is fully coked. Nominally this is 20 hours with a minimum of 14 hours and a maximum of 24 hours.

Standards for the biological plant effluent are:

Phenol: 60 mg/l average of 6 analyses with at least 24 hours between samples. No analysis to be above 90 mg/l. Mass standard based on 150 m^3/hr (660 gpm) over the entire year.

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Fixed Ammonia: 1200 mg/l average of 6 analyses with a maximum allowable of 1500 mg/l. Mass standard based on 150 m^3/hr (660 gpm) over the year at 1200 mg/l.

CN: No standard.

COD: 4500 kg/day.

Plant tax on water discharged has been in 1978 20 fl. per population equivalent (1 fl. is approximately US$0.50).

$$PE = \frac{Q}{180}(2.5\ BOD_5 + 4.57\ N)$$

$$BOD = \frac{COD}{2.5}$$

6-1/2"

N = Nitrogen in mg/l

Q = m^3/day yearly average

9-1/8"

Blast Furnaces

Hoogovens operates five blast furnaces, one with a capacity of 7000 Mg /day (7700 tons/day) 1 at 3000 Mg /day (3300 tons/day), 2 at 2300 Mg /day (2530 tons/day) and 1 at 1000 Mg /day (1100 tons/day).

Presently, all gas washer and gas cooling water are on a once-through system. The four smaller blast furnaces each have two venturi scrubbers. One of the smaller blast furnaces use 600 m^3/hr (2650 gpm) and the other four use lesser amounts. The largest blast furnace uses a Bishoff scrubber requiring 1000 m^3/hr (4400 gpm).

All gas cleaning systems use salt water drawn from the outer harbor and the dust together with the water are discharged to the harbor.

New standards call for thickeners to be built and in operation by 1982. The systems will call for $Ca(OH)_2$, CO and CO_2 will be removed by air. The settled water will be recirculated.

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The plant anticipates problems in disposal of the thickener sludge in that there is no land available for stockpiling or disposal. At the present time, it cannot be used at the sinter plant, as is the dust from the dry dust catchers, due to the zinc and lead content.

After the thickener is installed, the discharge standard will be: Zn-40 kg/day, Pb-10 kg/day, CN-0, H_2S-0, SS-50 mg/l (based on a blowdown of 100 m^3/hr (440 gpm) for all five furnaces). It is anticipated that, due to the high pH to be maintained in the blast furnace recirculation system, that they will be able to meet the CN standards.

TRIP REPORT

HYDROTECHNIC CORPORATION

VISIT TO PRETORIA WORKS, ISCOR

PRETORIA, SOUTH AFRICA

Subject: Study of superior non-U.S. technology for the treatment of coke plant and blast furnace wastes.

October 22, 1979

6-1/2''

Attending

For Pretoria Works	For Hydrotechnic
Mr. F.V.K. von Reiche	Mr. H.J. Kohlmann
Mr. G. Kornelius	Mr. H. Hofstein

Blast Furnaces

Pretoria Works operates four blast furnaces and the average daily production is: Nos. 1, 2 and 3 - 750 Mg (825 tons) each and No. 4 is 1800 Mg (1980 tons). The blast furnace gases first pass through dry dust catchers and then through wet gas cleaning systems. The water requirements for blast furnaces 1, 2 and 3 are 700 m^3/hr (3080 gpm) each and blast furnace 4 requires 910 m^3/hr (4000 gpm). The water systems are shown schematically on Fig. IP.1. A common treatment system is used for water for blast furnaces 1 and 2. In addition, the settled water from the Rotor (BOF) which has had the coarse solids removed is treated together with the Nos. 1 & 2 blast furnace water. Because of the low pH of the rotor wastes, lime is added at the splitter box for pH adjustment. Makeup to this system is non-contact cooling water blowdown from the coke ovens.

Clari-flocculator sludge, at 5% solids, is discharged to railroad cars for additional settling and thickening. The overflow from the railroad cars is directed back to the clari-flocculators. The clari-flocculator effluent is cooled and

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PRETORIA WORKS - BLAST FURNACE GAS CLEANING WATER SYSTEMS

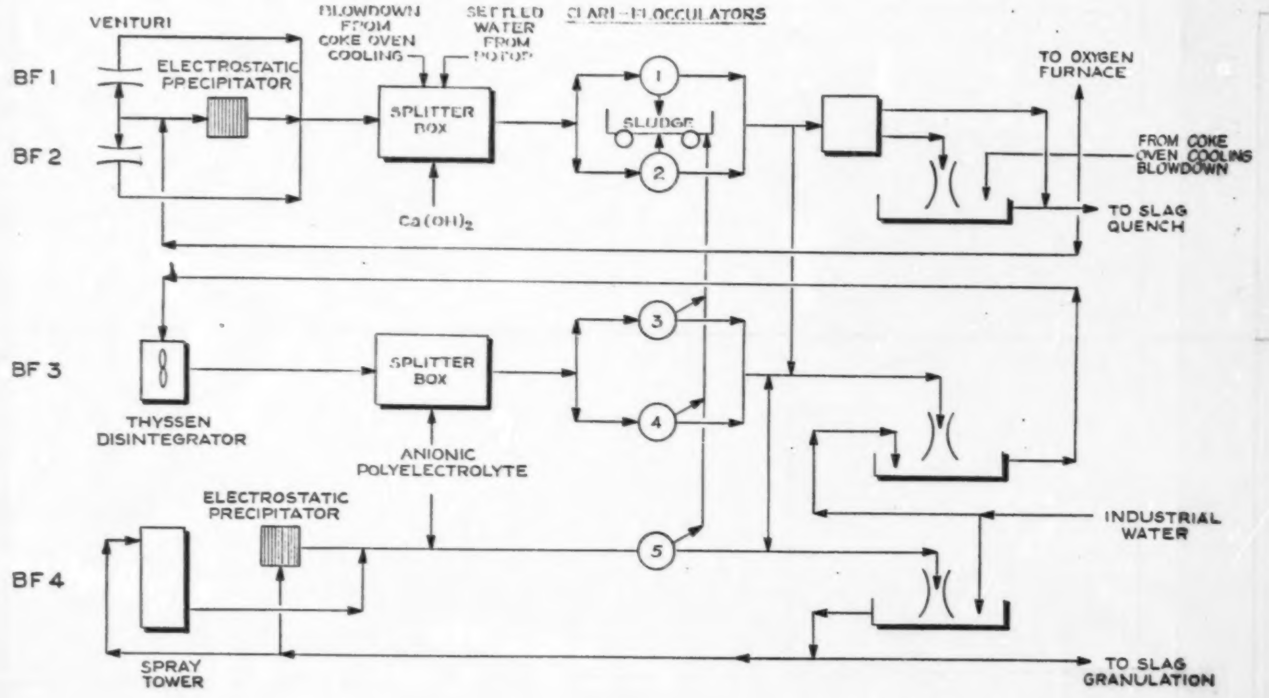
BF 1
BF 2
VENTURI
ELECTROSTATIC PRECIPITATOR
BLOWDOWN FROM COKE OVEN COOLING
SETTLED WATER FROM ROTOR
SPLITTER BOX
$Ca(OH)_2$
CLARI-FLOCCULATORS
1
SLUDGE
2
TO OXYGEN FURNACE
FROM COKE OVEN COOLING BLOWDOWN
TO SLAG QUENCH
BF 3
THYSSEN DISINTEGRATOR
SPLITTER BOX
ANIONIC POLYELECTROLYTE
3
4
INDUSTRIAL WATER
BF 4
ELECTROSTATIC PRECIPITATOR
5
SPRAY TOWER
TO SLAG GRANULATION

FIG. IP-1

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recirculated back to the blast furnace venturis, electrostatic precipitators and the Rotor. Excess water is discharged to slag quenching and to the blast furnace 3 gas cleaning cooling tower.

Wastewater from blast furnaces 3 and 4 are treated by settling, enhanced by the addition of an anionic polyelectrolyte. After settling the water is cooled prior to recycle. Blowdowns from the system is via sludge removal, and slag quenching from the No. 4 blast furnace cooling tower.

The total blowdown from the combined blast furnace systems is approximately 750 m^3/day (198,000 gal/day) to slag quenching and 750 m^3/day (198,000 gal/day) via sludge removal.

Water analyses provided are:

	pH	SS	NH_3	CNS	TDS	Tot.Hard. as $CaCO_3$	Cl-	MO Alk.
Recycled Cleaning BF 1 & 2, and	8.3	46	101	15	1350	500	350	334
Blowdown - BF 3 & 4	7.9	25	250	30	1500	800	-	600
Cleaning Makeup	7.6	30	-	-	-	200-400	120	-
Recycled Furnace Cooling Water	8.3	9	-	-	740-900	400	108	110
Furnace Cooling Makeup	7.8	0	0	-	400	150	40	-

(All except pH in mg/l.)

Before a polyelectrolyte was used as a settling aid alum was tried. However, since converting to polyelectrolyte, scaling has been noted in the recycle lines. The plant is considering adding sulfuric acid to lower the pH.

Sixty percent of the slag is granulated and sold to a cement manufacturer and the balance disposed of at a slag dump at which pickling sludge is also deposited. Quenching is carried out at the blast furnaces, where H_2S discharge is noticeable during quenching. The water that leaches from the bottom of the slag dump has a negligible COD, no H_2S odor, a TDS of 3000-5000 mg/l and is free of CN. The plant hypothesizes, but has not tested the hypothesis, that the CN destruction is due to biological action.

The sludge from gas cleaning is discharged to the slag dump with the slag from blast furnaces 1 & 2, the excess slag from blast furnaces 3 and 4 and the dust from the dry dust catcher. Blast furnace operators complain that the alkali in the blast furnace dust is recycled and adversely affects the blast furnace if the dust is sintered.

Coke Plant

Pretoria Works has four coke batteries operating with a total of 160 to 166 ovens. Repair work is being carried out, resulting in a varying number of ovens out of operation. The average production is 2800 Mg (3080 tons) of coke per day. By-products produced are ammonium sulfate, benzene, toluene and primary tar.

A schematic of the gas flow including the sources of wastewater and the disposition of these wastes is shown on Figure IP-2. Approximately 0.5 m^3 of water are applied per Mg (120 gal/ton) of coke quenched. The evaporation loss due to quenching is approximately 72.5 m^3/hr (319 gpm). Approximately 29 m^3/hr (128 gpm) of waste ammonia liquor is produced which is totally consumed in the quenching system.

Coal drying is practiced at the plant and scrubbers are used which blowdown approximately 30 m^3/hr (132 gpm).

An exact balance exists between coke plant wastes and coke quenching since there is strict segregation in the circulating water, dirty water and storm systems. The coal used is low in chloride so very little fixed ammonia is produced. The primary and secondary coolers are indirect and the blowdown is to the blast furnace systems to be used as makeup in the gas cleaning system.

The qualities of water that were provided are:

	pH	SS	NH_3	Phenol	TDS	Tot. Hard. as $CaCO_3$	Cl-	CNS
Tot. Quench	-	1000	650	300	2000	500-3000	-	200
Ind. Water	8.3	9	-	-	740-900	400	108	-
Softened Water	8.0	0	-	-	350	0.5	40	-

(All except in pH in mg/l.)

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PRETORIA WORKS BY PRODUCT COKE, GAS & WATER SYSTEMS

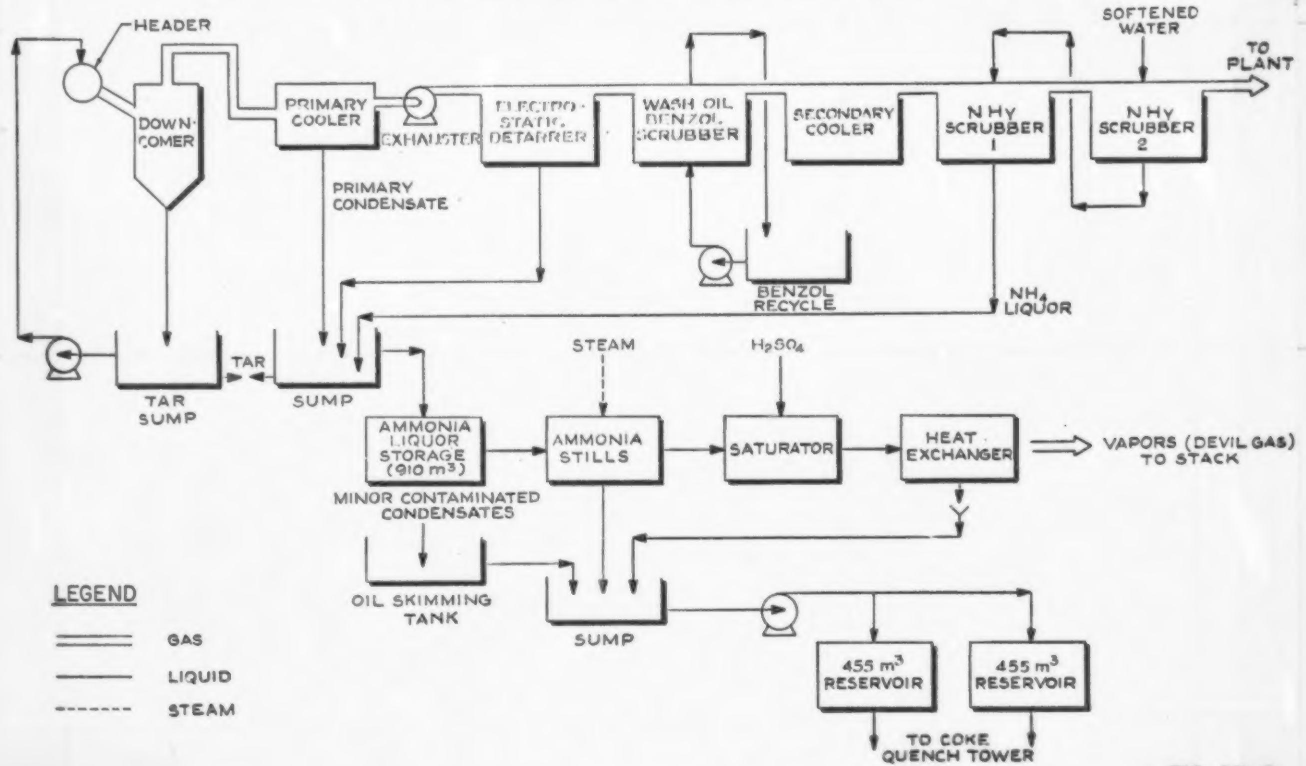
HEADER
DOWN-COMER
PRIMARY COOLER
EXHAUSTER
ELECTRO-STATIC DETARRER
WASH OIL BENZOL SCRUBBER
SECONDARY COOLER
N Hy SCRUBBER 1
N Hy SCRUBBER 2
SOFTENED WATER
TO PLANT
PRIMARY CONDENSATE
BENZOL RECYCLE
NH4 LIQUOR
TAR
TAR SUMP
SUMP
STEAM
H2SO4
AMMONIA LIQUOR STORAGE (910 m3)
AMMONIA STILLS
SATURATOR
HEAT EXCHANGER
VAPORS (DEVIL GAS) TO STACK
MINOR CONTAMINATED CONDENSATES
OIL SKIMMING TANK
SUMP
455 m3 RESERVOIR
455 m3 RESERVOIR
TO COKE QUENCH TOWER
LEGEND
GAS
LIQUID
STEAM

FIG. IP-2

General

The plant purchases 21,000 m^3/day (3,850 gpm) of drinking water at a cost of RO.19 per m^3 (approximately US $0.23 per m^3 or 87¢/1000 gal.). Of this approximately 6000 m^3/day (1.58 mgd) is softened for boiler feed and ammonia stripping. All other water is sent to cooling systems of which approximately 1/3 is used for the blast furnaces. The water is cascaded and the total plant blowdown is 5200 m^3/day (1,373,000 gal/day). A blowdown of 2200 m^3/day (580,000 gal/day) is consumed at the sinter plant and the total plant discharge of 3000 m^3/day (790,000 gpd) has approximately 1500 mg/l TDS. The plant discharge is combined with the City of Pretoria sewage treatment plant treated effluent, which dilutes it at a rate of 15:1. This water is used for irrigation. Approximately 50 miles downstream of the plant the water is used for domestic purposes.

General effluent standards have been established for the plant but the plant has proved to the authorities that relaxed standards are more applicable for some contaminants and these relaxed standards have been allowed. The standards are as follows (all except pH in mg/l):

Parameter	Plant Effluent	General Std.	Relaxed Std.
Phenol	1	-	-
Ammonia	20	10	15
Susp. Solids	30-40	5	30
4-hour Permanganate Value	25-30	10	50
CNS	2-3	-	-
Tot. Diss. Solids	1500-1600	50	1500
Oil	-	5	10

EPA-287 (Cin.)
(4-76)

TRIP REPORT

HYDROTECHNIC CORPORATION

VISIT TO NEWCASTLE WORKS, ISCOR

NEWCASTLE, SOUTH AFRICA

Subject: Study of superior non-U.S. technology for the treatment of coke plant and blast furnace wastes.

October 24, 1979

Attending

For ISCOR Newcastle	For Hydrotechnic
Mr. P. LeRoux	Mr. H.J. Kohlmann
Mr. J. Bothma	Mr. H. Hofstein
Mr. F.V.K. von Reiche	

Blast Furnaces

The new plant at Newcastle Works has one blast furnace producing approximately 2500 Mg (2750 tons) of hot metal per day although it is designed to produce up to 3000 Mg (3300 tons) per day.

After a dry dust catcher the blast furnace gas is cleaned in a Bischoff scrubber containing a variable throat venturi with three hydraulic cylinders. The scrubber requires approximately 1500 m^3/hr (6600 gpm) of water which is discharged to two 15-meter (49 foot) diameter degritters to remove the coarse fraction of the flue dust prior to its discharge to two 50-meter (165 foot) diameter clarifiers. The settled water is cooled and 1476 m^3/hr (6500 gpm) is recirculated. A makeup of 24 m^3/hr (106 gpm) is applied to the system to replace the water blown down to slag cooling. A polyelectrolyte is added to the water between the grit removal unit and the clarifiers. After clarification a dispersant is added.

EPA-287 (Cin.)
(4-76)

The degritter solids (85 percent D.W.) are disposed of at an outside dump and at the sinter plant. Approximately 3.5 kg (dry basis) of grit are produced per Mg (7 lbs/ton) of hot metal. The solids from the clarifier are dewatered in one of three vacuum filters and a portion of the dewatered sludge, at 60 percent solids, is sent to the sinter plant and a portion is dumped. Approximately 13.8 kg (dry basis) of solids per Mg (27 lbs/ton) of hot metal are removed in the clarifier. Therefore the total water lost from the system with the solids is approximately 31.5 m^3/day (8300 gal/day).

Slag cooling water is recycled and makeup is gas washer blowdown and blowdown for air conditioner system. Scaling problems have been encountered in the slag cooling system recycle lines.

Analyses of water provided are:

	pH	SS	CN	NH_3	TDS	Totl. Hard.	MO Alk.	SO_4	Cl
						as $CaCO_3$			
Gas cleaning water prior to treatment	7.5	531	13	117	2739	546	-	-	739
Makeup water	8.8	13	-	-	342	159	44	165	27
Tot. water to gas cleaning	7.7	50	11	119	2500	589	579	450	726

(All except pH in mg/l)

The blast furnace cooling system is closed using air cooling in fin and tube coolers. Minimal softened water is used for makeup to account for pump gland and other miscellaneous leakage.

Coke Plant

Newcastle Works has four coke oven batteries installed with 50 ovens per battery. Three of the batteries are operating and the average daily production per battery is 1500 Mg (1650 tons) but have a rating of 1550 Mg (1700 tons) per day.

The by-products plant produces crude phenol, tar, BTX, ammonium sulfate, sulfuric acid, naphthalene and oils. Two desulfurizers, a dephenolizer and two free ammonia stills are operated. The plant reports that there is little (<550 mg/l) fixed ammonia due to the low chloride and sulfate in the coal.

EPA-287 (Cin.)
(4-76)

Approximately 94 m^3/hr (414 gpm) is required for coke quenching which is composed of 46 m^3/hr (202 gpm) of H_2S and free ammonia stripped weak ammonia liquor, 32 m^3/hr (142 gpm) of seal water and 16 m^3/hr (70 gpm) of industrial water.

All of the water discharged from all other processes in the coke plant including cooling tower blowdowns, spillages, floor washings, heat exchanger flushing systems, etc., are collected and discharged to an irrigation system. This system will irrigate approximately 250 hectares (618 acres) and it is presently undergoing startup. If the system cannot accept the full flow, strong ammonia liquor will be used to quench coke and only the weak ammonia liquor will go to the irrigation system.

Water analyses provided are:

	pH	SS	NH_3	Phenol	TDS	Totl. Hard. as $CaCO_3$	MO Alk.	CNS	SO_4	Cl
Waste Ammonia liquor (same as Pretoria Works)	-	1000	650	300	2000	500-3000	-	200	-	-
Softened Water	8.0	-	-	-	300	1.2	-	-	-	-
Indust. Water	8.8	13	-	-	342	159	44	-	165	27

(All except pH in mg/l.)

EPA-287 (Cin.)
(4-76)

TRIP REPORT

HYDROTECHNIC CORPORATION

VISIT TO VANDERBIJLPARK WORKS, ISCOR

VANDERBIJLPARK, SOUTH AFRICA

Subject: Study of superior non-U.S. technology for the treatment of coke plant and blast furnace wastes.

October 23, 1979

Attending

For ISCOR Vanderbijlpark	For Hydrotechnic
Mr. H.J. Dreyer	Mr. H. Kohlmann
Mr. H.A.D. Gertzen	Mr. H. Hofstein

Blast Furnaces

Vanderbijlpark operates four blast furnaces. The average daily hot metal production is:

Furnace	A -	1360	Mg	(1490 tons)
"	B -	1360	Mg	(1496 tons)
"	C -	2200	Mg	(2420 tons)
"	D -	3000	Mg	(3300 tons)

Blast furnace gas is passed through dry dust catchers then through wet electrostatic precipitators at all 4 furnaces. A total of approximately 3500 m^3/hr (15,400 gpm) is used at all four furnaces for gas cleaning. The water from the precipitators at furnaces A & B are discharged to a splitter box and then to two Dorr-Oliver thickeners. The water from the precipitators at furnaces C & D flows directly to two other Dorr-Oliver thickeners. All thickeners have overflow rates of 1.7 m^3/m^2/hr (35 Imperial gallons per square foot per hour). The thickeners were designed to produce an effluent of 70 mg/l suspended solids without the use of coagulant aids. However, a coagulant aid is presently used to improve suspended solids removal.

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After settling, a total of approximately 35 m^3/hr (154 gpm) is blown down to be used for coke quenching and irrigation and the balance is cooled and recycled back to the electrostatic precipitators. The total makeup for all four blast furnaces is 128 m^3/hr (563 gpm).

Scale control is attempted by the addition of a polyester. However, the recirculation system has severe scaling on the cold side and severe corrosion on the hot side. Plant personnel think that if the iron in the suspended solids can be reduced, the scaling will be decreased.

Makeup water is from the Vaal River which is settled for suspended solids removal prior to use in the plant. Slag is air-cooled. There are no water discharges to public waters from the blast furnace gas cleaning system.

Blast furnace water analyses that were provided are:

	pH	SS	CN	NH_3	F	TDS	Totl. Hard.	Ca Hard.	Totl. Alk.
							as $CaCO_3$		
Makeup	8.6	13	-	-	-	703	357	219	129
Recycled Clng									
BF A & B	7.6	46	0.1	53.8	6.1	5136	2825	2292	75
BF C	7.8	42	9.7	81.3	9.2	3427	1765	1203	212
BD D	8.1	52	5.5	136	8.2	4589	1322	455	955
Blowdown to coke quench	-	-	2.0	100	8.0	-	-	-	-

(All except pH in mg/l.)

Coke Plant

Seven coke batteries operate and a new eighth battery will soon be commissioned. Each of the batteries has 55 ovens. The total coke plant production is designed for 7840 Mg (8624 tons) per day.

Four by-product plants are installed which produce ammonium sulfate and BTX. Tars are sent to ISKOP, an off-site company, for further processing and refining. The gas from 2 batteries is desulfurized.

Free ammonia stills are installed at all four by-products plants and the newest plant also has a fixed ammonia still that uses calcium hydroxide as the alkaline agent.

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Quench water is lost at a rate of 0.3 m^3/Mg (72 gal/ton) for a total of 98 m^3/hr (430 gpm). The makeup to the quench system is drawn from three sources: 35 m^3/hr (154 gpm) from the blast furnace gas cleaning system, 18 m^3/hr (79 gpm) from the industrial water supply and 45 m^3/hr (198 gpm) from the Nos. 1 & 2 ammonium sulfate manufacturing facilities (includes the excess waste ammonia liquor).

All contact wastewater from the coke plant is from the ammonia and sulfate wastewater facilities. The excess wastewater not used for quenching (approximately 140 m^3/hr (616 gpm) from No. 3 ammonium sulfate facility after oil skimming, and 20 m^3/hr (88 gpm) from Nos. 1 & 2 ammonium sulfate facilities) is discharged to maturation dams (holding ponds). Water from the maturation dams is pumped to an irrigation scheme where grass is grown and harvested for use as cattle feed. The maturation dams have a retention time of over one week. A limitation established for the grass is that it must not have a fluorine concentration in excess of 40 mg/l. This level has not been reached and the plant personnel feel that this is because fluorine is absorbed from the air rather than through the roots.

The plant plans to cease quenching and irrigation with coke plant and blast furnace wastewater and plans to biologically treat these wastes in a complete mix system. Consideration is also being given to treating the biological plant effluent by reverse osmosis and reusing the water produced as makeup to the plant.

Coke plant water analyses provided are:

	pH	SS	CN	NH_3	Phenol	F	TDS	Totl. Hard.	Ca Hard.	Totl. Alk.
									as $CaCO_3$	
Quench Makeup										
BF Gas Clng	-	-	2.0	100	-	8.0	-	-	-	-
Nos. 1 & 2 ammonium sulfate	8.2	-	109	280	162	-	-	-	-	-
Industrial Water	8.6	13	-	-	-	-	703	357	219	129
To irrigation after maturation dams	7.4	-	185	745	133	53	2928	343	250	-

(All except pH in mg/l.)

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General - The standards to be met by the discharges from the plant are:

pH	6.5-9.5	PO_4	10
SO_4	-	Na	200
SS	30	Cr^{+6}	0.05
F	2.0	Cr(tot)	0.5
CN	0.5	TDS	1000^+
NH_3 as N	10	Ether Extractables	5.0
Phenol	0.1	Permanganate value	10
NO_3 as N	5.0		

(All except pH in mg/l.)

The water application rate for the entire plant is 230 m^3/Mg (55,121 gal/t) of steel and the plant makeup is 6 m^3 of water/Mg of steel (1438 gal/ton).

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TRIP REPORT

HYDROTECHNIC CORPORATION

VISIT TO SVENSK STAL

NORRBOTTENS JARNVERK, LULEA, SWEDEN

Subject: Study of superior non-U.S. technology for the treatment of coke plant and blast furnace wastes.

March 7, 1979

Attending

For Svensk Stal	For Hydrotechnic
Mr. Kjell-Olof Jonsson Mr. Kjell Lundstrom	Mr. H.J. Kohlmann Mr. H. Hofstein

For Aquator

Mr. S. Holmberg

Coke Plant

The plant has one coke battery with 54 ovens and an average production rate of 2,000 Mg/day (2200 tons/day). Saleable by-products are tars and elemental sulfur.

Coke oven gas is cooled in primary and secondary coolers using recirculating ammonia liquor which is first passed through a tar sump. Excess waste ammonia liquor is stored in a holding tank and is subsequently used in a hydrogen sulfide (H_2S) washer. A portion of the wash water is carried through to the ammonia washer and the balance is discharged to the H_2S still. The complete system is shown diagrammatically below:

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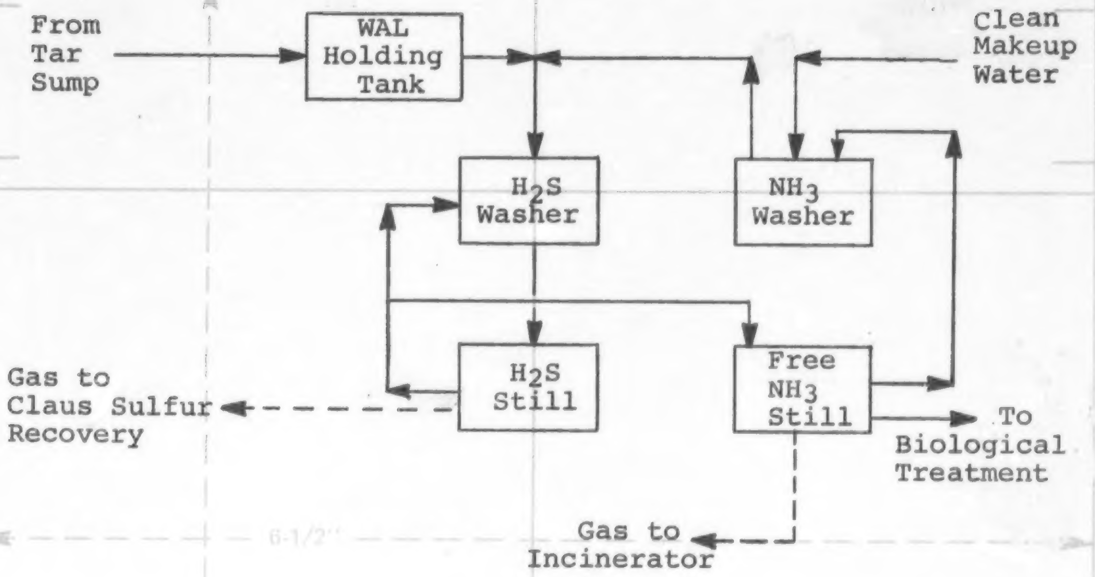
From Tar Sump
WAL Holding Tank
Clean Makeup Water
H2S Washer
NH3 Washer
H2S Still
Free NH3 Still
Gas to Claus Sulfur Recovery
To Biological Treatment
Gas to Incinerator

The coke oven gas is passed through a dry electrostatic precipitator to remove tars prior to reaching the H_2S washer.

The waste ammonia liquor, at an average rate of 40 m^3/hr (176 gpm), is discharged to an equalization basin where concentrated phosphoric acid (H_3PO_4) at 6 l/m (1.6 gpm) and 20% ferrous sulfate ($FeSO_4$) is added. pH is automatically controlled by the addition of sulfuric acid (H_2SO_4) or sodium hydroxide (NaOH) as required to maintain the pH between 6.5 and 8. The waste flows by gravity to a complete mix, activated sludge aeration basin with a detention time of approximately 24 hours and then to a clarifier. The clarified waste is used to quench coke. Excess sludge is discharged to coke quenching. No dilution water is added.

The entire activated sludge system is covered by concrete slabs to maintain an adequate temperature for biological activity.

The analyses of influent qualities are (all values except pH in mg/l):

pH	7-8
CNS	100-200
NH_3 (tot)	900-1000
NH_3 (free)	20-30
Phenol	500-600
HCN	0.2-0.3
H_2S	0.5
Cl	1500

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Mean effluent quality is (all values, except pH, in mg/l):

Phenol	0.3
NH_3 (tot)	1350
HCN	0.14
pH	7.4

Water requirements to quench coke are 1.9 m^3/Mg (456 gal/ton); therefore, the biological plant discharge is not sufficient to meet quenching requirements. The balance is made up of river water. Quench water is recycled to extinction.

There is no constant coal source. Different mixes of coal from the USSR, Poland, U.S., Germany, etc., are used.

Corrosion problems have been experienced in the gas train; therefore, the Claus sulfur recovery unit and the ammonia incinerator operate only approximately 75 percent of the time.

Blast Furnaces

The plant operates two blast furnaces, one with a capacity of 1,500 Mg /day (1650 tons/day) and one with a capacity of 3,000 Mg /day (3300 tons/day).

Both furnaces use dry dust catchers and wet gas cleaning. Blast Furnace No. 1 uses a cyclone and a wet electrostatic precipitator. Blast Furnace No. 2 uses a Bischoff scrubber. Each furnace uses from 600 to 900 m^3/hr (2640 to 3960 m^3/hr) of water for gas cleaning.

The gas cleaning water at each blast furnace is discharged to two thickeners and from there to a cooling tower for recirculation back to the gas cleaning system. Nalco 623 is added to the thickener influent to aid in solids settling.

Approximately 40 to 60 m^3/hr (176 to 264 gpm) of five percent sludge is discharged from both blast furnace systems to a sludge lagoon located approximately 2 km away from the blast furnaces. The lagoon is not lined and had a one-month detention time when constructed. It is not known what the present detention time is. Supernatant from the lagoon overflows to a second lagoon which receives cooling water from the balance of the plant and the total mixed flow overflows to the Lulea River.

The mean quality of the blast furnaces recirculating water was provided:

Parameter	BF #1	BF #2
pH	7.7	6.7
Susp. Solids (mg/l)	146	39
CN (tot) (mg/l)	85	10
Phenol (ug/l)	495	1845

The limitations established for discharge from both furnaces are CN (tot) - 4 kg/day and phenol - 2 kg/day. The plant has stated that there is no difficulty in meeting these limitations.

Although the only limitations are those described above, the plant monitors pH and NH_3 daily at the outfall and metals are analyzed once a month. No analyses were provided.

The quality of the river water is:

Parameter	
pH	6.6
SS	3.0 mg/l
CN	0 mg/l
NH3	0.1 mg/l
Sulfide	0 mg/l
Phenol	0 mg/l
F	0 mg/l
Fe (tot)	0.2 mg/l
SO_4	4 mg/l
TDS	very low
Cl	depends on river flow (up to 35 mg/l)
Hardness	(German) 0.4° (7 mg/l as $CaCO_3$)

TRIP REPORT

HYDROTECHNIC CORPORATION

VISIT TO SURAHAMMARS BRUKS AB

SPANNARHYTTAN, NORBERG, SWEDEN

Subject: Study of superior non-U.S. technology for the treatment of coke plant and blast furnace wastes.

March 8, 1979

Attending

For Spannarhyttan

Mr. M. Waller
Dr. L. Granas

For U.S. EPA

Mr. J. Ruppersberger

For Hydrotechnic

Mr. H.J. Kohlmann
Mr. H. Hofstein

For Aquator

Mr. S. Holmberg

The only facilities at Spannarhyttan are one blast furnace and a mold foundry. The 5.5 m (18 ft) hearth blast furnace was built in 1974 and has a design capacity of 320,000 Mg/yr (352,000 tons/yr). It operates at a rate of approximately 280,000 Mg/yr (308,000 tons/yr). During 1978 it produced 140,000 Mg (154,000 tons) of which 120,000 Mg (132,000 tons) were delivered to a steel plant 55 km south of the blast furnace. The balance was pigged.

Since the steel plant operates on a five days a week schedule, the blast furnace has also operated 5 days a week.

The blast furnace slag is air cooled and used to refill spent mines.

The blast furnace non-contact cooling system utilizes approximately 19.6 m^3/hr (86 gpm) makeup of boiler quality water. The water is cooled in a closed air cooled heat exchanger and the only losses are through system leaks.

The blast furnace gas cleaning system consists of dry dust catcher, a wet scrubber and a wet electrostatic precipitator.

The gas scrubber utilizes 150 m^3/hr (660 gpm) of recycled water sprayed into the gas stream at four points before the scrubber and in the scrubber at six points. After cooling, 50 percent of the gas passes through a wet electrostatic precipitator that utilizes a continuous flow of 4.4 m^3/hr (19 gpm) and a flushing flow of 60 m^3/hr (264 gpm) for ten minutes every half hour. The particulate content of the gas out of the electrostatic precipitator is 10 mg/m^3. The 50 percent of the gas not passed through the electrostatic precipitator has a particulate content of 100 mg/m^3. The gas is flared.

Wastewater from the scrubber, with a suspended solids concentration of 800-1000 mg/l, is discharged to a thickener and the water from the electrostatic precipitator is discharged to a pond and then pumped to the thickener. The slurry from the thickener is vacuum filtered to 60 to 70 percent solids and stockpiled since it is too high in Zn, Pb and alkali for reuse. The pH in the system is not controlled.

The overflow from the thickener is to a clean water tank from which 3 m^3/hr (13.2 gpm) is discharged to the pig casting circulating system and the balance back to the gas scrubber and the electrostatic precipitator. Approximately 0.5 m^3/hr (2.2 gpm) is made up to the clean water tank. When there is too much oil in the blast furnace water a dispersant is added.

The pig caster recirculation system operates at a pH of 10. The overflow from the pig casting water system first flows to a pond, then to a stream and then to a lake. The pond also receives rainfall runoff.

The gas cooling system utilizes 200 m^3/hr (880 gpm) which is cooled in an open cooling tower and recycled. Approximately 4 m^3/hr (17.6 gpm) makeup is added. Blowdown is to the gas washing system. The blowdown is controlled but not measured. The quantity is based on the cooling tower basin level.

To prevent the thickener and pond from freezing during the winter weekend periods when the blast furnace was not operating, steam was added to the thickener and in doing so, the CN concentrations were reduced from 30 to 2.4 mg/l. Hydrogen peroxide (H_2O_2) was used to oxidize the CN but did not prove successful, probably because the pH was not high enough.

Analytical data provided was at three points in the water system as follows for a ten week period:

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(4-76)

	pH	CN (mg/l)
Discharge from the pig caster	9.0-11.3	0.25-1.4
Discharge from the pond	8.0-8.6	0.10-0.26
Downstream of the pond	7.1-7.4	0.07-0.14

The blast furnace gas cleaning system operates at a 98 percent recycle rate because the facility is located in a water short area.

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TRIP REPORT

HYDROTECHNIC CORPORATION

VISIT TO CHINA STEEL CORPORATION

KAOHSIUNG, TAIWAN

Subject: Study of superior non-U.S. technology for the treatment of coke plant and blast furnace wastes

May 14, 1979

6-1/2"

Attending

For China Steel Corp.	For Hydrotechnic
Mr. Kuo - Chin Liu	Mr. H. Hofstein
Mr. T.Y. Kuo	Mr. J. Chu
Mr. C. T. Chen	
Mr. Patrick P.C. Shen	

Blast Furnace

The China Steel Corporation plant at Kaohsiung is new and operates one blast furnace with an average production of 4000 Mg (4400 tons) per day.

The blast furnace cooling water is recirculated in a closed system. The cooling water is softened and cooled in a heat exchanger. Bottom spray water is treated water and is discharged to the coke quenching system at the coke plant and to other cooling water systems as makeup water.

The blast furnace gas is first treated by passing it through a dry dust catcher and then through a two-stage venturi scrubber. Approximately 1200 m^3/hr (5280 gpm) of water is used for the gas cleaning which is treated for suspended solids removal, cooled and then recirculated. Approximately 10 m^3/hr (44 gpm) is blown down to the industrial waste lagoon where it is mixed and diluted with other wastewater.

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The 1200 m^3/hr (5280 gpm) of solids laden wastes are discharged to the thickener where the solids are settled out. Other waters discharged to the thickener which serves as a part of the makeup to the system are once-through air conditioning water and the sludge from the solids contact softening unit at the treated water plant. To aid in solids settling a polyelectrolyte is added at a rate of 0.5 to 1.0 mg/l. The thicker overflow is cooled and recirculated. Additional makeup from the treated water reservoir is added at the cooling tower basin.

The sludge underflow from the thickener is dewatered on a vacuum filter and the filtrate is returned to the blast furnace thickener. Approximately 70 to 100 Mg (77 to 110 tons) of sludge cake at 40 per cent solids is sold to a local cement company.

Analyses of water in the blast furnace systems are shown on Table CS-1.

6-1/2"

Coke Plant

China Steel operates one coke battery consisting of 78 ovens with an average of 115 charges daily and coke production of 2403 Mg/day (2640 tons/day). Coke quenching water usage is about 0.6 m^3/kkg of coke produced. The source of water is from the B.F. bottom spray and the treated industrial water system. The quench water is recycled at a rate of 150 m^3/hr (660 gpm) and the makeup rate is 60 m^3/hr (264 gpm). There are no discharges.

The by-products plant produces ammonia, tars, BTX and coke oven gas.

Approximately 20-30 m^3/hr (88 to 132 gpm) of waste ammonia liquor is produced and passed through an ammonia still that strips free ammonia only. Approximately 25 m^3/hr (110 gpm) of benzol plant wastes are combined with the stripped waste ammonia liquor and passed through a roughing filter with coke as a media and then discharged to an aerated reservoir.

The coke filter is a chamber filled with ungraded coke and removes tars from the wastewater. Initially, 3 to 4 years of operation was estimated, but the coke actually requires changing once a year. The exhausted coke is charged back to the coke ovens with the coal.

In addition to the coke plant wastes approximately 20 m^3/hr (88 gpm) of sanitary wastes that have passed through

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TABLE CS-1
BLAST FURNACE - WASTEWATER QUALITY
(All analyses except pH in mg/l)

Description	pH	SS	CN	NH_3	Phenol	F	TDS	Zn^{++}	Hardness as $CaCO_3$ Total	Ca	Mg
Non-Contact Furnace Cooling Make-up Water (Zeolite Softened Water)	8.2	<10	0	0	0	0	300	-	<5	-	-
Recycled Cleaning (Clarified Effluent)	7.5	20	<0.2	-	-	-	1200	0.6	680	480	170
Total Cleaning (Gas Cleaning Water to Scrubber)	7.9	-	-	-	-	-	1000	-	-	460	160
Cleaning Discharge (Scrubber Effluent)	-	500	-	-	-	-	-	-	-	-	-

a bar screen, a comminutor and a degritter are also discharged to the aeration basin.

The total flow of approximately 65 m^3/hr (286 gpm) flows to a conventional activated sludge biological treatment plant. The aeration time is approximately 17 hours in one of two aeration tanks. The mixed liquor suspended solids in the aeration tank is maintained at approximately 5000 to 6000 mg/l. The other tank is to be used for the wastes from a second coke plant to be built. After aeration the wastes are discharged to a 20 meter (66 foot) diameter clarifier. The sludge from the clarifier is partially recycled to the head end of the aeration tank. The excess sludge is discharged to a 4.5 meter (15 ft.) diameter thickener and the underflow sent to a belt filter press where the sludge is dewatered to approximately 20 percent solids. The sludge is mixed with inorganic solids and sold to a local cement company.

The overflow from the clarifier is discharged to a chlorine contact tank with a 15-minute detention time and then to the industrial waste lagoon. The total wastewaters collected in the industrial waste lagoon is discharged to a creek connected to the adjacent Kaohsiung Second Sea Harbor. The effluent from the lagoon has a light brown color.

Analyses of the water at the coke plant and the waste treatment plant are shown on Table CS-2.

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TABLE CS-2

BY-PRODUCTS & SANITARY WASTE TREATMENT ANALYSES

(All values except flow & pH in mg/1)

Description	Flow (m^3/hr)	pH	SS	CN	Fixed NH_3	Phenol	Oils & Grease	TDS	COD	Total Hardness as $CaCO_3$
Treated Makeup Water	10	8.0±	<10	-	-	-	-	320	-	150
Sanitary Wastes	20	-	-	-	-	-	-	-	55	-
Coke Plant By-Product Flow to Coke Filter	50	8.9	40-50	10	600-700	500	10	-	1000-1300	-
Wastes from Reservoir to Treatment	20	8	20±	<10	500	250	10	-	800	-
Treated Effluent	80	8	<60	0.18	360	0.5	7.5	-	50-100	-

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TRIP REPORT

HYDROTECHNIC CORPORATION

VISIT TO ROECHLING-BURBACH STEEL WORKS

VOLKLINGEN, WEST GERMANY

Subject: Study of superior non-U.S. technology for the treatment of coke plant and blast furnace wastes.

March 12, 1979

Attending

For Roechling

Dr. Pfeiff
Mr. Egner
Mr. Schumann
Mr. Drechsel
Mr. Flasche

For Hydrotechnic

Mr. H. Kohlmann
Mr. H. Hofstein

For U.S. EPA

Mr. J. Rupersberger

The Roechling-Burbach Steel Works consists of three iron and steel plants in the Saar River basin. Two other plants, Dillingen and Halberg are in close proximity but are owned by other groups. Each of the installations, Volklingen, Burbach and Neunkirchen have both blast furnaces and coke plants. The main reason for this visit was the Volklingen installation.

Blast Furnaces

The six blast furnaces at Volklingen utilize three totally dry gas cleaning systems. The normal gas temperature is approximately 200°C. When needed, water is used to regulate the temperature at the top of the furnace where it evaporates into the gas. The gas is then used at other in-plant installations for fuel. The water that condenses in the gas mains is collected in drip legs at the mills and is discharged untreated to the plant sewer system. The quality of the condensate was not provided.

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Of the approximately 7500 m^3/hr (33,000 gpm) of the blast furnace non-contact cooling water, approximately 1500 m^3/hr (6600 gpm) is used for slag granulation and the excess, not retained in the slag is discharged to the canal. Approximately 3400 m^3/hr (14,960 gpm) is returned to two return water basins from where it is pumped into the process water system. The balance of the cooling water is discharged to the canal.

Coke Plant

At Volklingen four coke oven batteries with a total of 172 ovens are operated with a capacity of 2000 Mg /day (2200 tons/ day). Approximately 2 to 4 m^3 (480 to 960 gallons) of water per Mg (ton) required for coke quenching is drawn from the Saar River and is settled in a breeze pit for approximately 25 minutes before being discharged to Canal XVII. It is not recycled. The total volume of water discharged to the Saar River from the coke plant is approximately 180 m^3/hr (792 gpm). This includes quench water, indirect cooling water and flushing water. The total volume of makeup is reported to be 500-700 m^3/hr (2200 to 3080 gpm).

Figure RB-1 is a schematic diagram of the Volklingen coke plant and blast furnace water systems. Table RB-1 presents the analyses at the sampling points.

Waste ammonia liquor at a rate of 15-20 m^3/hr (66-88 gpm) is passed through a free ammonia stripper and is dephenolized by ether extraction producing approximately 1 kkg per day. At Volklingen the stripped and treated water is discharged to slag granulation. Softened water is used to scrub the ammonia from the coke oven gas. A portion of the coke oven gas is desulfurized for use at reheat furnaces.

At Volklingen municipal wastes are discharged untreated with the plant water. Plans are to build a sewage treatment plant to treat the Volklingen plant wastes, plus the wastes from two small towns (total population about 30,000 people). Part of the river flow is from the Rossel River from France which is high in phenol and solids. Because of the quality of the river the German government will not pay to build the sewage treatment plant until the French clean up their stream.

At Burbach, Neunkirchen and D illingen, the ammonia from coke oven gas is treated with sulfuric acid (H_2SO_4) to produce ammonium sulfate ($(NH_4)_2SO_4$).

The waste ammonia liquor that has been stripped of free ammonia is treated in a biological plant.

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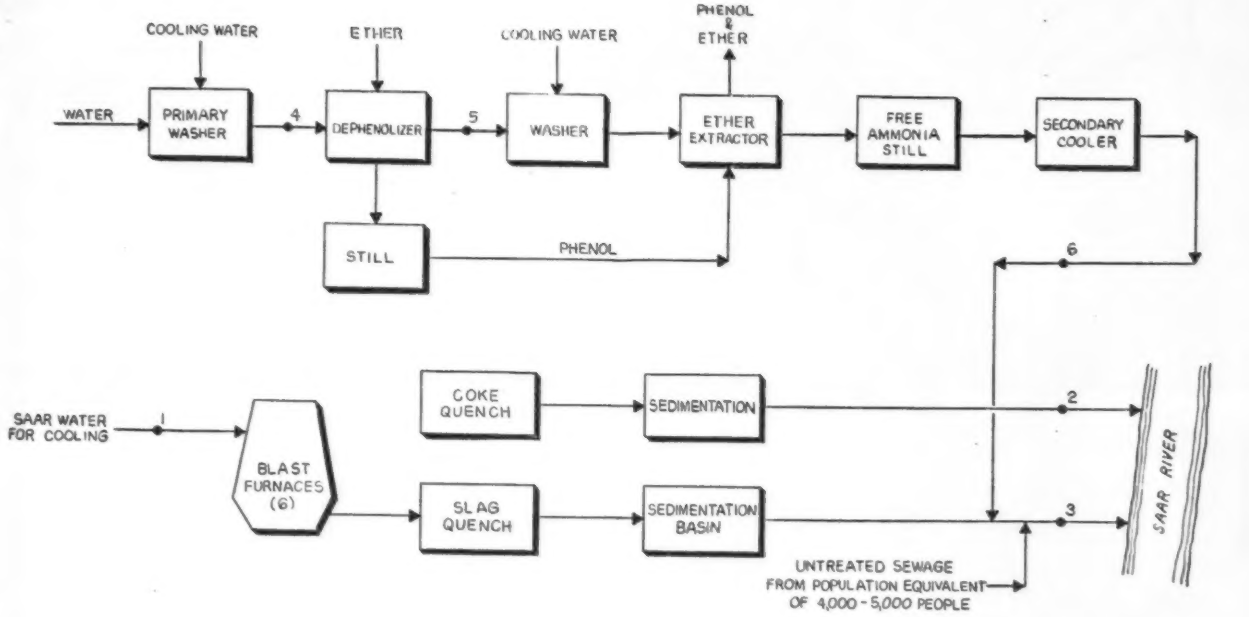
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ETHER
COOLING WATER
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WASHER
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FREE AMMONIA STILL
SECONDARY COOLER
STILL
PHENOL
6
SAAR WATER FOR COOLING
1
BLAST FURNACES (6)
COKE QUENCH
SEDIMENTATION
2
SLAG QUENCH
SEDIMENTATION BASIN
3
SAAR RIVER
UNTREATED SEWAGE FROM POPULATION EQUIVALENT OF 4,000 - 5,000 PEOPLE

NOTE
- ● INDICATES ANALYSIS POINT SHOWN ON TABLE RB-1

ROECHLING-BURBACH-VOLKLINGEN PLANT
SCHEMATIC FLOW DIAGRAM OF BLAST FURNACE
AND COKE PLANT WATER SYSTEMS

FIG. RB-1

TABLE RB-1

ANALYSES OF WATERS AS INDICATED AT POINTS ON FIGURE RB-1

No.	Description of Source	pH	Settleable Solids 2 hr - ml/l	Suspended Solids (mg/l)	Dissolved * Solids (mg/l)	COD mg/l	Chloride (mg/l)	Sulphate (mg/l)	Cyanide (mg/l)	Ammonia Total (mg/l)	Ammonia Free (mg/l)	Phenol (mg/l)	Oil & Grease (mg/l)	Hardness °German (mg/l as $CaCO_3$)	Iron Total (mg/l)	Iron Dissolved (mg/l)	Sulfide (mg/l)
1	Saar River makeup water	7.3-7.6	< 0.1-0.3	-	526-620	14-20	51-156	62-105	0.001-0.016	1.0-6.3	-	<0.01 0.08	<0.1-0.3	11.2-20.5 (200-365)	0.50-6.00	0.08-0.35	-
2	Coke quench basin overflow	7.8-9.0	0.2-0.8	116-195	403-1310	30-155	59-310	79-162	0.009-2.55	8.8-150	-	0.07-16.0	<0.1-1.9	-	0.55-6.7	0.09-0.34	-
3	Slag quench discharge (includes waste ammonia liquor and untreated sewage)	7.5-8.0	0.1-0.3	38-81	385-1230	19-42	65-404	78-150	0.042-0.245	15.0-27.7	-	0.02-0.28	0.2-3.8	-	3.2-11.9	2.8-11.9	
4	Primary washer discharge	8.6	0.2	-	-	4590	-	-	161	6600	2330	613	-	-	-	-	480
5	Dephenolizer discharge	9.2	< 0.1	-	-	2750	-	-	156	6700	2350	4.5	-	-	-	-	400
6	Waste ammonia	9.2	< 0.1	-	-	1240	-	-	39.4	3750	562	52.5**	-	-	-	-	< 0.1

* Residue after evaporation at 110°C.

** Believed to be incorrect value.

The Burbach plant coke plant biological treatment plant was visited. This plant consists of a single stage, biological treatment plant. Sulfuric acid, phosphoric acid, anti-foaming chemicals and iron sulfate are added to the influent for pH control, nutrients, foaming control and floc formation. The wastes are mechanically aerated in a 9.4 meter (30 ft) diameter by 6.0 meter (20 ft) water depth aeration tank prior to discharge to a 6.0 meter (20 ft) diameter by 3.5 meter (11.5 ft) water depth clarifier. Sludge is recycled. Presently the sludge is discharged to a dump but in the future the sludge will be discharged to the sinter plant with steel making sludge. The flow through the plant is 12.5 m^3/hr (55 gpm) to which 38 m^3/hr (167 gpm) of fresh water is added for dilution. Influent and effluent analyses as of 1974 are as follows (all values in mg/l):

	Influent	Effluent
Phenol	1143	0.06
Cyanide free	4.7	0.34
Sulfur	7.0	0.41
NH^+ (total)	3678	820
NH^{+4} free	1090	180
COD^4	4910	402
Permanganate value	10,680	355

The maximum limits for discharge are:

Phenols - 2 mg/l, cyanide - 2 mg/l, and sulfur - 5 mg/l.

The Biological Plant at Neunkirchen was not visited but a copy of a paper was provided which contained the following information which has been condensed.

The influent level for the coke plant wastewater treatment facilities is as follows (all values, except pH, in mg/l):

pH	9.1
Free ammonia	1200
Total ammonia	1500
Cyanide	43
Phenol	400-600
Sulfide	118
COD	3000-5000

The biological treatment plant consists of an aeration tank with four surface aerators. The overflow from the aeration tank is directed to two settling basins where sludge is recycled and also discharged to a sludge dewatering system. Iron sulfate and phosphoric acid are fed to the influent of the aeration tank. Dilution water is in a ratio of from 1:1 to 1:2.

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The average effluent quality from the plant is (all values, except pH, in mg/l):

pH	8.5
Phenol	2.9-5.3
Cyanide	0.16-1.01
Sulfide	0.4-1.9

The Dillingen biological plant is similar to the one installed at Burbach.

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TRIP REPORT

HYDROTECHNIC CORPORATION

VISIT TO AUGUST THYSSEN-HUTTE

AKTIENGESELLSCHAFT (ATH)

DUISBURG, W. GERMANY

Subject: Study of superior non-U.S. technology for the treatment of coke plant and blast furnace wastes

March 21, 1979

Attending

For Thyssen AG	For Hydrotechnic	For U.S. EPA
Dr. J. Philipp	Mr. H. Kohlmann	Mr. J. Ruppersberger
Dr. R. Endell	Mr. H. Hofstein	
Mr. Schmitz		
Mr. H. Drescher		

August Thyssen-Hutte (ATH) is a complex of iron and steel producing plants located on the Rhine River near Duisburg, West Germany. The works visited are identified as the blast furnace works at Hamborn/Schwelgern. The total water recirculation rate is 97%. All of the wastewater is discharged to the Emscher River for treatment by the Emschergenossenschaft at their water treatment plant located where the Emscher River meets the Rhine River. The steel plant is charged for water supplied to the plant from wells located along the Rhine River (0.25 DM per m^3) and is also charged for discharges to the Emscher on the basis of flow and contaminant load.

Coke Plant

The coke plant at Hamborn consists of five batteries with a total of 294 ovens. The capacity is 10,000 Mg /day (11,000 tons/day) of coal charged but due to total blast furnace

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capacity the coke plant only operates at a charging rate of 8800 Mg /day (9680 tons/day).

Pushing, charging and screening emissions are controlled by wet scrubbers operating on a once-through system with the water discharged to the coke quenching operations. The screening emissions control system water provides approximately ten percent of the quench makeup requirements and the pushing and charging emission control system provides an additional ten percent.

The non-contact recirculating cooling system blowdown provides the balance of the coke quenching system requirements and the blowdown is regulated based on the coke quench system requirements. Algae growths have been a problem in the cooling towers due to the high dissolved oxygen in the makeup water.

Approximately 0.56 m^3 (148 gallons) of water is required per Mg of coke quenched. The quench water is recycled to extinction. The recycled water has a pH of from 10 to 11 and a suspended solids content of 30 g/l. There are no analyses for dissolved solids and corrosion or erosion has not been noted in the system. The coke breeze basin is mechanically cleaned to protect the pumps and the solids are sent to the sinter plant.

Products produced at the by-products plant are: 30 percent phenolics in water, tars, benzene extract, naphthalene dissolved in benzene and sulfuric acid, all of which are sold.

Coke oven gas is stripped of ammonia and hydrogen sulfide which are then incinerated and sulfuric acid is manufactured. The gas then passes through a benzene stripper and the resultant liquor is discharged.

Waste ammonia liquor is discharged to a dephenolizer and then to a free ammonia still. The ether extraction dephenolizer is owned by the Emschergenossenschaft and is operated by the steel plant. The stripped waste ammonia liquor is discharged to the Emscher River together with other plant wastes for treatment with all other industrial wastes from the area.

The plant must perform toxicity tests on a specific specie of fish to determine the coke plant wastewater dilution rate which will not prove toxic to the fish after 24 hours.

The plant has determined that at a dilution of approximately 64:1 the requirement is met. The wastewater from the coke ovens is combined with the Blast Furnace and Power House wastes. The combined discharge is toxic to fish at a dilution rate of 16:1. Analyses provided are as follows:

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	Coke Plant Discharge (before dilution)	Combined Discharge
Flow (m^3/yr (gallons/yr))	$2x10^6$ ($528x10^6$)	$11x10^6$ ($2904x10^6$) [$2x10^6$ ($528x10^6$) from coke $8x10^6$ ($2112x10^6$) from BF $1x10^6$ ($264x10^6$) from power]
pH	8.3	8.1
SS (mg/l)	19	12
SS (mg/l) (after 2 hrs settling)	0.5	-
CN (mg/l)	0.022	0.002
NH_4^+ (total) (mg/l)	261	42.9
SO_4 (mg/l)	-	153
Phenol (mg/l)	0.2	0.05
Oil & Grease (mg/l)	-	1
Cl^- (mg/l)	-	541
NO_3 (mg/l)	-	15.7
NO_2 (mg/l)	-	3
Total Fe (mg/l)	-	1.8
Mn (mg/l)	-	0.64
Zn (mg/l)	-	0.64
Total Solids (mg/l)	-	1520
Cd (mg/l)	-	0.005
COD (mg/l)	-	65.8

Before dilution the phenol concentration is 10 mg/l and there is an average of 200 mg/l fixed ammonia and a maximum of 20 mg/l free ammonia.

Blast Furnace

There are 7 closed circuits required for the cooling of the furnaces and stoves. They are pressureless systems using nitrogen as a seal and demineralized water is used as makeup. For all technical equipment approximately 120 m^3/hr (528 gpm) of drinking water quality is purchased and demineralized in ion exchangers. Hydrazine is used for oxygen scavenging and sodium phosphate is used for scaling control. A pH of 9.8 is maintained for corrosion control. The closed circuit water is cooled by fans. The ion exchange regenerants are neutralized and discharged to the Emscher River. In emergencies Rhine River water is used.

The system was selected on the basis of water quality, the cost of water and pumping energy saved. The Rhine River has

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thermal regulations; therefore, the maximum blowdown is 30 m^3/day (7920 gal/day).

The gas cleaning system is an open recirculating system with makeup as blowdown from the oxygen plant and from air conditioning.

Thyssen has three sets of blast furnaces. Of the three, only Schwelgern BF No. 1 was observed but all three are typical. The wastes from the scrubber are discharged to an aeration basin where air is injected to strip out CO and CO_2 from where it is discharged to a 30 m (100 ft) diameter rim drive clarifier. $CaCO_3$ precipitate that has formed in the aeration basin settles with the flue dust. A portion of the sludge from the clarifier is recycled to act as a seed for the settleable solids. A Nalco polyelectrolyte is also added. The balance of the sludge is pumped to a filter press where it is dewatered to a cake of 75 percent solids. A total of 20 Mg /day of solids (dry basis) is discahrged.

From 2600 to 2800 m^3/hr (11,440 to 12,320 gpm) of clarified water is cooled in open cooling towers and recycled. The water has a pH of 8.0, suspended solids of from 10 to 20 mg/l, and a hardness of 23.7° German (approximately 420 mg/l as $CaCO_3$).

The blowdown of 30 to 40 m^3/hr (132 to 176 gpm) from the system is pumped at a high pressure and used for slag quenching in a series of covered slag pits. When the pit is filled with slag it is dewatered by draining and the water is recycled. The slag is used for cement manufacture at a cement plant located on the site. There are occasional blowdowns to the Emscher River.

Other Observations

There was a noticeable lack of fugitive emissions in the blast furnace cast house. There are four taps at the furnace. Slag and iron are tapped simultaneously. The entire tapping system is covered and there are three suctions over each tap system. A total of approximately 700,000 m^3/hr (24.7×10^6 ft^3/hr) of air is exhausted to a bag house containing 2000 bags with a total surface area of 12,000 m^2 (129,000 ft^2).

The plant is very concerned with noise in the surrounding area and all installations are soundproofed.

Approximately 20 percent of the entire plant area is dedicated as green areas. Rabbits were observed in these green areas.

TRIP REPORT

HYDROTECHNIC CORPORATION

VISIT TO HOESCH HUTTENWERKE AG

DORTMUND, W. GERMANY

Subject: Study of superior non-U.S. technology for the treatment of coke plant and blast furnace wastes.

March 22, 1979

Attending

For Hoesch	For Hydrotechnic	For U.S. EPA
Mr. R. Simon	Mr. H. Kohlmann	Mr. J. Ruppersberger
Mr. J. Steuer	Mr. H. Hofstein	

Hoesch Huttenwerke has two plants, Phoenix Works and Westfallen Works. Phoenix Works has three blast furnaces, two with capacities of 3000 Mg/day (3300 tons/day) and the third with a capacity of 4500 Mg/day (4950 tons/day). Westgallen Works has two blast furnaces each with a capacity of 4500 Mg/day (4950 tons/day).

The tuyeres and hot blast valves are cooled in a closed circuit cooling system using air cooled heat exchangers. At full production the water application rate is 10,000 m^3/hr (44,000 gpm). Any makeup water to the system is demineralized and degassed. Oxygen scavenging chemicals are added.

At Phoenix two furnaces with stoves and one with cooling boxes use evaporatime pressureless (0.4 bar (5.9 psi)) systems. At Westfallen one furnace uses heat exchangers and one uses a steam turbine. There are four blowers with gas turbines and the waste gas of two have waste heat boilers. Part of the waste heat is used to heat local schools and other parts are used to heat office buildings.

The furnace bottom and sides use open evaporation cooling.

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The cooling circuit uses side stream sand filters for suspended solids control.

At full production the open recirculating cooling systems require 65,000 m^3/hr (286,000 gpm) with chemical addition of sodium hexametaphosphate and "phosphone acid". The blowdown from the system is used as makeup to the gas cleaning systems. Makeup to the entire plant water system is city potable water and seepage to the tunnel.

Gas cleaning at two of the Phoenix furnaces is by quenchers followed by wet electrostatic precipitators. One furnace uses a Lurgi system. The cleaning water from the three furnaces is discharged to three clarifiers operating in parallel. The gas cleaning flows are 1500 m^3/hr (6600 gpm) and 1400 m^3/hr (6160 gpm) for the two smaller furnaces and 1130 m^3/hr (4972 gpm) for the larger. The combined overflow rate is approximately 0.5 m/hr (0.1 ft/min). The settled water is pumped to two cooling towers located above two of the clarifiers and then recirculated back to the gas cleaning system. The gas cleaning water to the thickeners has a suspended solids content of 400 mg/l or higher and the clarifier effluent is approximately 50 mg/l. No chemicals are used to enhance settling. Blowdown from the system is via sludge disposal at a rate of approximately 250 m^3/day (46 gpm) per furnace from the clarifiers to sludge lagoons. The sludge has a solids content of approximately 1½ percent.

Polyphosphate is added to the recirculating gas cleaning water cooling tower. Due to air stripping, the polyphosphate addition and the formation of iron-cyanide complexes, the cyanide content in the gas cleaning water is very low. However, the plant does not feel that the influence of the cooling towers is important because of the low cyanide concentration in the gas cleaning circuit (0.2 to 0.4 mg/l). The cyanide removal by adding polyphosphates is limited by a maximum cyanide concentration of 10 mg/l. Higher concentrations, which may occur during furnace shutdowns, disturb the chemical reactions.

Due to stripping of carbon dioxide from the water in the cooling tower an increase in pH of one unit is experienced.

At Westfallen Works the gas is cleaned in a venturi and is then quenched. Approximately 1200 m^3/hr (5280 gpm) per furnace is used. The water treatment system is identical except that there are two clarifiers instead of three. The system blowdown is at a rate of 250 m^3/day (46 gpm) per furnace to two sludge ponds. Approximately 120 m^3/day (22 gpm) of cold rolling mills sludge is also pumped to the Westfallen Works sludge ponds which increases the pH. The Phoenix Works sludge has sodium hydroxide added to raise the pH.

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Each plant has two ponds operated alternately. When the level in one pond has reached a predetermined depth, the sludge is pumped to the other pond until the level in the first pond stops falling and then the operation is reversed. Each plant's pond system covers approximately two hectares. In the past 10 to 20 years they have been filled with solids to a depth of 10 m (33 ft). The plants anticipate that they are sufficient for an additional 10 to 20 years of operation. The solids are approximately 50 percent iron. By the time the ponds are filled to capacity, Hoesch anticipates that there will be a reasonable technology available whereby the iron and zinc can be economically recovered from the sludge.

The water in the ponds seeps through, is collected in 1 m (40 in) diameter open joint pipe, and is discharged to a river: Phoenix Works to the Emscher River and Westfallen Works to the Lipper River. At Phoenix Works the pond also is equipped with an overflow pipe.

Analyses provided for Westfallen of the water to the lagoon and the filtrate from the lagoon were provided as follows:

	Water to the Westfallen Lagoon from BF	Water from the Westfallen Lagoon*
pH	6.5-7	9
SS (mg/l)	20,500	50
CN (mg/l)	0.2	0.1
Ether Extractables (mg/l)	-	5
$SO_4^=$ (mg/l)	300	800
NH_4^+ (mg/l)	40	-
Conductivity (uS/cm)	1200	2300
Total Hard** (as $CaCO_3$)	275	430
Cl (mg/l)	400	240
Zn (mg/l)	up to 100	0.2
Sn (mg/l)	-	1
Cr (tot) (mg/l)	-	0.5
Fe (tot) (mg/l)	-	1.6
TOC (mg/l)	-	20 (approx)
COD (mg/l)	-	60 (approx)
Alk (P) (as $CaCO_3$)	0.0	1.2
Alk (M) (as $CaCO_3$)	2-3	3.2

* Includes cold rolling mill sludge water
** Converted from value reported as m Val/l.

The plant has theorized that the reduction in cyanide is due to the cyanide complexing with the iron and staying in the sludge. The reduction in zinc is thought to be by precipitation at the high pH and remains in the sludge due to the filtering action.

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APPENDIX C

COST ESTIMATES

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APPENDIX C

COST ESTIMATES FOR BLAST FURNACE RECIRCULATION AND COMBINED COKE PLANT AND BLAST FURNACE WASTEWATER TREATMENT

In preparing the capital, operating and annual cost estimates for the proposed system, the following assumptions were used:

Cost of Mechanical Equipment - Unit prices for pumps, motors, piping, sludge mechanisms and dewatering equipment have been established based on manufacturers' quotations.

Engineering, Administration and Contingencies are standard at 30 percent of estimated capital cost.

Operation and Maintenance

Operating Personnel - An hourly rate of $12.50 was used for operating personnel and $20 for supervisory personnel. These rates include fringe benefits and overhead.

Taxes and Insurance - Estimated at two percent of the capital cost.

Equipment Repair and Maintenance - Estimated at eight percent of the installed equipment cost not including contingency.

Materials - Chemical costs have been estimated based on prices in the May 1980 issue of "Chemical Marketing Reporter":

Polymer	$ 5.51 per kg
Phosphoric acid	0.53 per kg
Caustic	0.275 per kg
Lime	71.65 per Mg
Methanol	0.188 per liter

Costs of chemicals to control scaling and corrosion in cooling towers have been based on costs at similar works in operation.

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Energy - Electrical costs are based on motor horsepower ratings and a cost of $0.03 per kilowatt-hour. Steam has been assumed to be supplied from other plant operations and is therefore not included in costs.

Amortization - Capital costs are amortized over 15 years at an interest rate of 10 percent. (Annual capital recovery = 0.13147 times capital cost).

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HYDROTECHNIC CORPORATION
CONSULTING ENGINEERS
NEW YORK, N.Y.

COST ESTIMATE

SHEET NO. 1 OF 2
JOB NO. 78-EPA-04

COMBINED COKE PLANT & BLAST FURNACE

SUMMARY

BY JSS DATE 6/13/80
CHKD. BY ____ DATE ____

ITEM	DESCRIPTION	UNIT	QUANT.	UNIT COST	TOTAL COST
	I. BLAST FURNACE RECIRCULATION				
I.1	AERATION BASINS (2)				442,800
I.2	THICKENERS (3)				1,838,000
I.3	PUMPS & BLOWERS BLDG.				1,232,500
I.4	COOLING TOWER				1,120,500
		SUBTOTAL I		$	4,633,800
	II. CENTRAL TREATMENT PLANT				
II.1	EQUALIZATION BASIN (1)				751,800
II.2	AERATION TANKS (2)				1,232,000
II.3	FINAL CLARIFIERS & BLOWERS BLDG.				596,000
II.4	CHEMICAL, VACUUM FILTERS & FILTERS BLDG.				3,087,000
II.5	THICKENER (1)				78,000
II.6	SOLID CONTACT CLARIFIER (1)				86,500
II.7	CLARIFIER (1)				245,000
		SUBTOTAL II		$	6,076,300

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HYDROTECHNIC CORPORATION
CONSULTING ENGINEERS
NEW YORK, N.Y.

COST ESTIMATE

SHEET NO. 2 OF 2
JOB NO. 78-EPA-04

COMBINED COKE PLANT & BLAST FURNACE

SUMMERY

BY JSS DATE 6/13/80
CHKD. BY ____ DATE ____

ITEM	DESCRIPTION	UNIT	QUANT.	UNIT COST	TOTAL COST
	III. COKE PLANT PRETREATMENT & WASTE CONVEYANCE TO CTP				
III.1	FIXED AMMONIA STILL				500,000
III.2	BENZOL PLANT & FINAL COOLER WASTES				168,500
		SUBTOTAL III		$	668,500
	ENGINEERING, ADM. & CONTINGENCY @	30%			3,416,400
	TOTAL CAPITAL COST			$	14,800,000

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PAGE NUMBER

COST ESTIMATE

COMBINED COKE PLANT & BLAST FURNACES

ANNUAL COST

I. AMORTIZATION (CAPITAL RECOVERY)

(@ 10% INTEREST RATE FOR 15 YRS.

CRF = 0.13147)

14,800,000 X 0.13147 = $1,946,000

II. O & M

1. OPERATING PERSONNEL (SALARIES & WAGES)

2 SUPERVISORS @ $40,000/YR = 80,000

6 SHIFT OPERATORS @ $25,000/YR = 150,000

230,000

2. EQUIPMENT REPAIR & MAINTENANCE

(@ 8% OF INSTALLED EQUIPMENT COST)

$6,750,000 X 0.08 540,000

3. MATERIAL (CHEMICALS)

POLYMER:
52.2 KG/DAY X 365 D/YR X $5.51/KG = 105,000

LIME:
100 KG/DAY X 365 X $\frac{1}{1000}$ X $71.65/MG = 2,600

COST ESTIMATE

COMBINED COKE PLANT & BLAST FURNACES

ANNUAL COST

PHOSPHORIC ACID:
663 KG/d X 365/YR X $.53 LB. = 128,200

METHANOL:
189 L/D X 365 X $.188/L = 13,000

CAUSTIC: 140 KG/D X 365 X $.275 KG = 14,100

COOLING TOWERS CHEMICALS = 50,000

TOTAL CHEMICALS $ 312,900

4. TAXES & INSURANCE

(@ 2% OF THE CAPITAL COST)

$14,600,000 X 0.02 = 292,000

5. ENERGY (POWER)

2000 KW/HR X 24 X 365 X $0.03 KW-HR = 525,600

TOTAL ANNUAL COST $3,846,000

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(4-76)

APPENDIX D

FOREIGN GOVERNMENT AGENCIES

GOVERNMENT AGENCIES

ARGENTINA

Obras Sanitarias de la Nacion
Marcelo T. de Alvear 1840
Buenos Aires, Argentina

AUSTRALIA

New South Wales Pollution Control Commission
Union Carbide Building
157-167 Liverpool Street
Sydney, N.S.W. 2000, Australia

ENGLAND

Department of the Environment
2 Marsham St.
London SW1, England

JAPAN

Environment Agency
Kasumigaseki, 3-1-1
Chiyoda-ku, Tokyo 100, Japan

Ministry of International Trade and Industry
Environmental Protection Policy Division
Tokyo, Japan

MEXICO

Subsecretaria de Mejoramiento del Ambiente
Av. Chapultepec No. 284 - 6 Piso
Mexico 7, D.F.

THE NETHERLANDS

Ministry of Health and Environmental Protection
Dkt. Reijersstraat 12
Postbox 439
2260 AK Leidschendam, Netherlands

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Rijksinstituut voor Zuivering van
Afralwater (RIZA)
Maerlant 6 / postbus 17
Lelystad, Netherlands

SOUTH AFRICA

South Africa Department of Water Affairs
312 Charter House
179 Bosman St.
Pretoria, South Africa

SWEDEN

The National Swedish Environment Protection Board
Smidesvagen 5
Fack
5-171 20 Solna, Sweden

TAIWAN

Taiwan Water Pollution Control Agency
South Division Control Center
250 Zen-Te St.
Chien-Gin District
Kaohsiung, Taiwan

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(4-76)